Antiseptic Therapeutics.

VOLUME I.

By Dr. E. L. Trouessart,

borax have both been used for many years in medicine.

Boric acid is solid, crystallizable in transparent colorless plates, soluble in cold water (1 to 25), much more soluble in warm water; soluble in five parts of glycerin and in sixteen parts of alcohol at 90° C. It is but slightly toxic—25 grammes was on one occasion swallowed by a sick person without poisonous effects.

The antiseptic power of boric acid is really extremely weak; Miquel ranks it among the substances *moderately* antiseptic (equivalent, 7.50 grammes); but its therapeutic value is greatly enhanced by its extreme innocuousness. It is much used, either alone or associated with other more powerful antiseptics.

Boric acid prevents fermentation and putrefactions; it retards the development of bacteria without killing them. In the form of powder it is more active than in solution, though a saturated solution of $\frac{4}{100}$ is sufficient to arrest the harmful action of pathogenic microbes.

To obtain concentrated solutions of boric acid (solutions exceeding 4 per cent.), magnesia or the carbonate of magnesia is added. M. Puaux indicates the following formula:

Boric acid	100
Magnesium carbonate	14
Water	1000

Mix and gently warm.

ANTISEPTIC THERAPEUTICS.

BY

DR. E. L. TROUESSART,

PARIS, FRANCE.

TRANSLATED BY E. P. HURD, M.D.

VOLUME I.

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DETROIT, MICH.

TABLE OF CONTENTS.

CHAPTER II.

TRANSLATOR'S PREFACE.

The work of Trouessart on Antiseptic Therapeutics, which forms Volume XXI of the Charcot-Debove series, is here reproduced because, in the judgment of the translator, it is the best treatise on the above subject that has yet appeared. The recent great advances in Bacteriology, and the increasing prominence in medicine, surgery, and obstetrics given to Antiseptics, have created a demand for a work of this kind.

While it is admitted that the subject of antiseptic therapeutics is still in an undeveloped condition, yet tentatives to supply a present want are always in order. Possibly men of the next decade will declare this treatise to be antiquated and behind the times. It may be that the progress of the next decade will be away from pharmaceutical antiseptics in the direction of serotherapy. Certain it is, however, that the problem will still continue to be—how to formulate an internal antiseptic medication that shall not injure the living cells and tissues of the organism.

The author of this book is a well known authority on Fungi. He is the author of a book on MICROBES, FERMENTS AND MOULDS, which constitutes Vol. LVII of the International Scientific Series.

The translator has generally given the formulæ as they stand in the original work. It is surely time that all the physicians of this generation were educated up to the decimal system of pharmacy.

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ANTISEPTIC THERAPEUTICS.

INTRODUCTION.

The profound revolution which has been accomplished in the study of general diseases by the discovery of microscopic organisms (microbes or bacteria) which are incontestably the cause of a great many of them, cannot fail to have its influence on the treatment of diseases. This result, however, has been a little slow to come about, and one cannot but be struck with the difference which still exists in this respect between surgery and general medicine.

On the one side, antisepsis and asepsis considered as indispensable, and imposed as an absolute rule, not only in surgical operations properly so called, but also in gynæcological practice, in obstetrics, in ophthalmology, and in rhinology.

On the other side, the treatment of internal diseases remaining almost the same as it was twenty years ago, or making but indecisive and timid borrowings from the antiseptic method.

Even in the numerous cases where there remains no doubt as to the microbian nature of the affection, physicians do nothing or do very little to combat the injurious action of the microbes or of their products (*toxines*), and the suffering organism has the conflict to sustain unaided. Antisepsis is not yet, as it ought to be, the first and the principal preoccupation of the physician as it is that of the surgeon.

The reasons of this difference are multiple, and pertain to the very nature of the mode of interven-

tion. Clinicians have asked in earnest if the antiseptic when introduced into the digestive tube is not much more dangerous than when it is simply applied to the skin or upon a solution of continuity thereof. This objection might have had greater weight at an epoch when physicians knew hardly any antiseptics but corrosive sublimate and phenic acid. It has hardly any force now that our therapeutic arsenal possesses an admirably graded series of products borrowed for the most part from organic chemistry (aromatic series), which, to quote Bouchard's expression, are in determined dose toxic for such and such a microbe, and not toxic to any of the animal cells.

The microbian theory, moreover, by reason of recent advances, is undergoing a remarkable evolution, of which it is necessary to speak briefly, for it directly concerns the question of the internal employment of antiseptics.

The microbes, we know, do not act solely by their presence, like a parasitic plant which derives its nutriment from the organism in which it is implanted. Their action is more complex. Most of them, and particularly the most dangerous—those of cholera, of tetanus, and of diphtheria, for instance—act especially by their products of secretion (toxines), liquids analogous to the venoms and diastases, veritable poisons, poured into the organism and carried by the blood to the nervous centres even before the multiplication of the parasite has assumed proportions corresponding in degree to the acuteness of the general symptoms which indicate a rapidly fatal affection.

It is not, then, so much the microbe itself as its toxine-producing function which constitutes the dan-

ger; and experience shows that it is not necessary to administer the antiseptic in massive doses capable of destroying the microbe — a dose relatively feeble suffices to neutralize the action of the latter, *i.e.*, to prevent its multiplying and producing the toxine which is peculiar to it. Thereupon the organism, rid of the poison which was paralyzing its normal functions, gets the better of the microbe, which is speedily eliminated, and the patient recovers his health.

But we may go farther, and enlarge considerably the field of antiseptic medication. In a great number of diseases we observe all the symptoms which ordinarily characterize the microbe-diseases, but we have not been able to discover any microbe to which might be attributed the origin of the affection. Such are the inflammations consecutive to alterations of nutrition; of these, acute rheumatism is the most complete type.

The cause of these diseases is a perversion of the functions of certain cells of our tissues and organs — cells which pour into the economy abnormal matters, or even normal ones in exaggerated proportion. These matters constitute veritable toxines whose effects are similar to those of the toxines fabricated by the pathogenic microbes. This similarity is a fact which should not cause surprise. The natural history of the cell, histological element of all our tissues, shows that it possesses an organization and properties similar to those of the microscopic animal or vegetal cells which live as parasites in the organism and are designated under the general name of microbes. The former, when perverted in their function, diseased, become thereby veritable parasites, foreign bodies, which the organism hastens to eliminate by the well known processes of inflammation, just as it does in dealing

with the microbes. This is why the general symptoms (hyperthermia, nervous troubles, etc.) are the same in both cases.

The elimination of these toxines, whatever may be their origin, is effected by the kidney, by the intestine, or by the skin; and this it is that explains why fever is lighted up whenever the kidney is overworked or its functions impeded, as is often the case in inflammations. This also explains why diuretics, purgatives, and sudorifics have a favorable and truly antiseptic action in all the inflammations, because they remove not only the toxines secreted by the microbes and by the altered cells, but also the microbes themselves and these dead or dying cells, true débris of the organism, which now only serve to encumber the organs, and which form in the circulatory stream, and more particularly in the kidney, obstructions which constitute an immediate danger to the entire economy.

We know, in fact, that the kidney is the principal and almost the only door of exit for the microbes which multiply in the blood. This explains the frequency and the danger of the nephrites in general, and of the infectious nephrites in particular.

But this notion also gives us valuable indications from a therapeutic point of view, and experience shows that the antiseptics act on the diseased cells, as on the microbes, by neutralizing their noxious action —by disinfecting them, as we used to say; by preventing them from secreting toxic substances, as we say today. In fact, the antiseptics act on the inflamed cells of our internal organs just as they do on the cells of superficial wounds, and in both cases the rapid return of the tissues to the normal state is the consequence of an antisepsis rational and proportionate to the gravity of the lesion.

It is, however, well to bear in mind that if the inflammation may be frank, non-microbian, yet the microbe is everywhere present—it may be *dormant*, but ready to revive and grow and destroy when the conditions become favorable. The trouble of the organism—the traumatism, the inflammation—may open the door to the parasite. Hence the complications, unceasingly menacing, which insidiously transform a simple and curable inflammation into an infectious, and it may be rapidly mortal, disease.

Acute articular rheumatism, a disease which is not essentially microbian, is one of the affections in which complications of a disastrous kind are frequent; and without speaking of secondary or *pseudo-rheumatisms* consecutive to blennorrhagia, to scarlatina, to dysentery, to mumps, to puerperal affections, have we not sometimes observed as a sequel of a simple otorrhœa of long standing, an articular pseudo-rheumatism, rapidly fatal, without cardiac complications, although confounded by its symptoms of invasion with ordinary acute rheumatism? It is important, then, from the onset of any inflammatory disease, even supposing it to be a simple cyclical affection, to institute an antiseptic treatment proportioned to the gravity of the symptoms. And whether the medicament acts as an aseptic, *i.e.*, as a prophylactic agent, or as an antiseptic, *i.e.*, a curative agent, whether it neutralizes the toxic action of the microbes or that of the degenerate cells of our own tissues, its useful action will be none the less easy to recognize. It is when the kidney, obstructed or inflamed, badly performs its functions, and the toxines thrown back on the intestine threaten it with inflammation, that it is eminently necessary to protect the vast absorbent surface which this organ offers. The antiseptic med-

ication then comes powerfully to the aid of the milk diet and purgatives, which cannot be indefinitely repeated without causing a new danger.

In fine, the reactions of our inner tissues (inflamed mucous and serous membranes, etc.) in presence of foreign substances (desquamated cells, microbes, or toxines) are not different from the reaction of the subcutaneous connective tissue when laid open by a wound; and the same treatment should apply to both cases.

But we have to take account in internal medicine of the special conditions of the inner environment, and of the difficulty of bringing a medicament to bear on the organ or organs inflamed. In most cases we have to be content with aiming at *general antisepsis;* but the *local antisepsis* will often follow as a consequence of this, and the final result will be only the more surely attained.

Before pursuing this study any farther, it will be well to take a glance over the changes which have been effected in the description of diseases which pertain to internal pathology by the recent progress in bacteriology.

GENERAL CONSIDERATIONS ON THE MICROBIAN DISEASES.

The general infectious diseases which are exclusively caused by the presence of a specific microbe may be either acute or chronic.

In the first class are diphtheria, tetanus, mumps, glanders, typhoid fever, typhus, cholera, yellow fever, epidemic cerebro-spinal meningitis, the sweating sickness, influenza, pertussis, blennorrhagia, etc.,

—diseases produced by microbes of a vegetal nature belonging to the family of *Bacteriaceæ.**

Intermittent fever (malaria), and some other affections more localized (vegetant folliculitis, Paget's disease), have for their cause microscopic organisms of an animal nature belonging to the class *Sporozoa.*

The general chronic diseases caused by bacteria are tuberculosis, leprosy, actinomycosis, rhinoscleroma, beri-beri, dental caries. We should doubtless add syphilis and canine rabies.

Other diseases, the microbic nature of which has only recently been recognized, are peculiar in that they are either caused or complicated by the presence of numerous microbes (microbic associations), of which one or more species may predominate, according to the case. Such are certain forms of pneumonia and of pleurisy, bronchitis, meningitis, peritonitis, dysentery, etc., as well as erysipelas, lymphangitis, phlebitis, pyæmia, septicæmia, gangrene, the puerperal inflammations, metritis, etc., and all the general diseases consecutive to wounds—diseases which belong to both medicine and surgery and are often characterized by the presence of pus.

To go a step farther, we find in the train of these and other diseases such affections as the endocardites, the myocardites, the infectious nephrites, the metastatic abscesses, and the purulent arthrites, analogous to those mentioned above in connection with infectious pseudo-rheumatism.

As will be seen, the field of microbiology is vast, but it would be wrong to give it an exaggerated ex-

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*Smallpox, measles, scarlatina, are doubtless microbe diseases, but their specific microbes (probably micrococci) have not yet been discovered and cultivated.

tension on the supposition that it includes all pathology. The affections not microbic are more numerous still, for they comprehend all the neuroses, the dyscrasiæ, the neoplasms, and even many inflammations which are due to physical and chemical causes foreign to the virulent action of the microbes. At the same time these affections, by debilitating the organism and vitiating the functional activity and histological renovation of the organs, open the door to microbic complications. Antiseptic treatment is then as urgently demanded as if the primary disease were of an infectious nature, whether to combat the deleterious effects of the toxines secreted by the organism itself, or to fortify the organism against complications from without.

In all cases it is important to distinguish between microbic and non-microbic diseases; to know to what particular species the pathogenic bacterium belongs; and, when the infectious disease is a complication, to determine at what precise moment the microbe makes its appearance. This is the object of that new science called Bacteriology.

Without doubt, the constant resort to the microscope as an indispensable aid to the diagnosis and prognosis of diseases is a hardship to the ordinary practitioner whose early teaching may have lacked expert training in this regard, and who is used to the traditional methods; but just such difficulties have always been encountered in the beginning of scientific progress in all departments.

What auscultation was to the physicians of the first third of this century, what the cell theory was twenty-five years later to the succeeding generation, the microbian doctrine is to the practitioners of to-day.

Histology has shed a brilliant light upon the diagnosis of all those neoplasms which were once confounded under the common names of tumors and cancers. So, also, bacteriology has given a new illumination to the pathology of inflammatory processes, and the definitive triumph of the microbic theory will be the advancement of clinical medicine.

How many problems, remaining unsolved by the ancient methods of diagnosis, are now made plain by the aid of the microscope!

Why, for instance, is meningitis curable in certain cases, and fatal in others? It is because the tubercle bacillus is not the sole cause of the disease, but other microbes (as the pneumococcus) may produce it in a much less malignant form.

Likewise, not all the pseudo-membranous anginas (formerly confounded under the general name of diphtheria) are caused by the Klebs-Loeffler bacillus, for there is a pneumococcus-diphtheria which is relatively benign. On the other hand, the pseudo-membranous angina of scarlatina is due either to the Klebs-Loeffler bacillus (Cornil and Babes) or to the pus-streptococcus (Wurtz and Bourges), the latter being especially active in early angina. Thus we see that the same inflammatory process may be produced by different microbes, each tissue having but one way of defending itself against the irritation produced by the presence of parasites and their toxines. The nature and virulence of these toxines has, moreover, the greatest influence on the final issue of the disease. Some epidemics of diphtheria may be due to the true Klebs-Loeffler bacillus, of which the toxines are very virulent; these epidemics may prove to be very fatal. In other and far milder epidemics, less malignant microbes may predominate, and the success of the

practitioner will be greater. The pseudo-diphtheritic anginas are sufficiently common.

Again, in presence of acute inflammatory swellings of the joints, we must be prepared to diagnose between acute rheumatism and infectious pseudo-rheumatism, a much more serious and intractable malady.

The nosography of internal diseases must, then, be entirely reconstructed in the light of modern bacteriology. This work of revision is begun on all sides, and the results already obtained are such that we can foresee that it will be far advanced in a few years. Hardly ten years have elapsed since the first attempts to construct a microbian pathology were made; much has been accomplished, and many of the principal difficulties have been overcome. Under the stimulus of the new pathology, chemists are every day enriching the materia medica with new antiseptics, and the future is full of promise.

GENERAL CONSIDERATIONS ON THE ANTISEPTIC MEDICAMENTS.

We are indebted to the microbian theory for the clearer light which we possess to-day as to the true mode of action of those medicines, at first employed empirically, which have long been designated as *specifics: e. g.*, mercury in syphilis, and quinine in malaria. These medicines are in reality *antiseptics*, and do good principally because they antagonize the microbes which engender the diseases. They are so little specific that one of these salts, the bichloride of mercury, may be considered as the most powerful agent of general antiseptic therapeutics. As for quinine, its tonic action is probably closely linked to its antiseptic action.

The microbic theory has enabled us better to comprehend the mode of action of a great number of medicaments, and, consequently, to define and extend the therapeutic indications. Instances of the suggestive value of the microbic doctrine in practice could easily be multiplied. Let us suppose the physician has to do with a phlegmon or a lymphangitis: under the influence of the old-time notions he would prescribe an antiphlogistic treatment, and would lose valuable time in the application of poultices and other emollients; but if, on the other hand, he is well imbued with modern ideas and convinced of the microbic nature of the lesion, he will employ immediately the antiseptics. Carbolic sprays or mercurial inunctions will speedily promote resolution of the inflammation, while the old antiphlogistic method would only result in suppuration, abscesses, and the necessity for surgical interference.

CLASSIFICATION OF MEDICAMENTS.

Considered from the point of view of their mode of action on the organism, and in a general manner, therapeutic agents may be divided into three great classes:

1. Medicaments which act directly on the organism itself, in modifying the altered functions of the organs in a manner favorable to a return to the normal state; such are the alkaloids, and all agents of a like kind, medicaments which we call *eusthenic* (from two Greek words: ευ, *well*, and σθενος, *force*).

2. Medicaments designed to prevent any constitutional effect from the alterations undergone by the organs; such are calmatives and palliatives; we designate them under the name of *hypnotics*.

3. Medicaments which do not act directly on

the organism itself, but on foreign matters thrown out by the tissues or originating from without the organism (microbes, exudates, toxines); these are *antiseptics*.

The eusthenics are supposed to act on the cells of the organs, and generally on healthy cells, which alone can respond by modification of function. The eusthenics, of all medicines, act most energetically on the organism itself.

Hypnotics act principally on certain special cells —the nervous cells—and their effect is to interrupt momentarily the communication existing between the sick organ and the cerebrum, so as to suppress pain.

Antiseptics act differently. Their action is directed for the most part against the agents of the disease coming from without, or against cells which, though formerly part of the economy, have by the fact of disease become foreign thereto and injurious. In short, the antiseptic medicament is addressed directly to the cause of the disease; and if it does not always reach this from the onset, it at least prevents this cause from prolonging and increasing its effects. Thus antisepsis realizes better than any other therapeutic method the desideratum so long sought as the Utopia of medicine, the *jugulation* of acute diseases.

If we were disposed to classify therapeutic indications according to their importance, we should arrange them in the following order:

1. Antiseptic therapeutics.
2. Eusthenic therapeutics.
3. Hypnotic therapeutics.

It is evident that a good system of treatment will aim to carry out, simultaneously or successively, the three indications which should present themselves to the mind of the physician precisely in the order in

which we have just mentioned them: (1) indications furnished by the cause which has produced the disease; (2) indications furnished by the diseased organism and the greater or less resistance which it offers to the disease; (3) indications furnished by the element of pain.

I hardly need say that there are medicines which by their complex action belong to all three of these groups. Such, for instance, is antipyrin (analgesin), whose action as a hypnotic and as a hypothermic (eusthenic) is well known, but which possesses besides, like all the products of the aromatic series, an incontestable antiseptic action.

Besides, in fortifying the organism by a judicious eusthenic treatment, and in preventing suffering, you will indirectly prescribe antiseptic medication, and enable the organism better to resist the causes of infection which threaten it. This is what is designated in a general way as "physiological therapeutics."

DEFINITION OF ANTISEPTICS.

A complete and general definition it is hard to give. To the chemist, antiseptics include all means capable of preventing fermentations and putrefactions by killing or stopping the development of the microbes which are their cause.

Vallin, in his Treatise on Disinfection, regards as antiseptics only those substances which prevent the decomposition of matters susceptible of putrefaction; he calls those drugs *neutralizers* that destroy or render inert virus and miasms, *i. e.*, microbes. According to Le Gendre, this distinction is no longer justified, as the progress of microbiology renders more and more subtle the difference between putrid infections and virulent diseases.

As the *toxines* constitute the principal danger, a comprehensive definition must not overlook them; and we may therefore say that the antiseptic medication is that which has for its end the destruction of the microscopic organisms which find entrance into the economy, and the septic principles which are developed under their influence or from any other cause.

Yet the chemical nature of virus, of soluble ferments, and of toxines is still so little understood that in most cases it is impossible for us to indicate what might be properly called their antidote. We are therefore obliged to rely on the antiseptics which act only on the microbes, producers of these toxines; at the same time we cannot refuse the name of antiseptics to medicaments which act similarly on the degenerate cells of the organism, for these also secrete toxines, as we have said above.

We ought also, by extension, to apply the name of antiseptics to therapeutic agents employed to combat the virulent action of toxic substances (soluble ferments, animal venoms) introduced into the organ ism under a liquid form and without the figured element (cell or microbe) which gave origin to them.

But therapeutic agents designed to combat the *poisons* properly so called—chemical substances of mineral or organic origin—are not classed as antiseptics, but *antidotes*.

Bouchard's definition, "An antiseptic is anything which directly impresses the life, multiplication and functionating of a microbe, *i. e.*, in doses inoffensive to man,"* seems to me not sufficiently general in the present state of science. Instead, I think the fol-

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* Bouchard, *Therapeutique des Maladies Infectieuses*, pp. 84 and 119.

lowing more definite and practical: *Antiseptic medicaments are such as are calculated to destroy or to arrest the development of microbes which have found entrance into the organism, and to neutralize the action of the septic principles developed as a consequence of the presence of such microbes or from any other cause, or introduced ready-formed from without.*

The antiseptics actnally in use are either medicaments anciently known and empirically employed under the name of "disinfectants" and "specifics," or substances recently introduced into the materia medica by the progress of modern chemistry.

These therapeutic agents have a double action: on the organism of man, and on the pathogenic microbes. To estimate precisely this double action, we begin by experimentally testing these chemical products in our laboratories; such experiments are of two, and even three, sorts:

One set of experiments makes known the action of the product in question on a given pathogenic microbe sown in a culture field of artificial liquid having a chemical composition similar to that of the liquids which the microbe meets in the organism.

Another series is instituted to determine the toxic action of the same product on animals of an organization more or less like that of man (hares, guinea-pigs, etc.), in order tentatively to ascertain the maximum dose which can be administered without danger to these animals first, then to man.

In a third series of experiments we endeavor to ascertain the therapeutic rôle of the product under consideration. We inoculate an animal with the microbe in order to produce a certain disease; the disease having been produced, we administer the antiseptic. A second animal inoculated in the same

manner, but not subjected to the antiseptic dosage, serves for the control-test.

Then only, if the preceding experiments have given a favorable result, one will dare try a new product on man, giving it first in doses much smaller than those which experimentation on animals had indicated theoretically as the non-toxic dose for the human organism, and afterwards augmenting progressively or diminishing the dose, according to the effect produced.

These last series of experiments, practiced in the hospitals with all necessary prudence and every precaution needed in order to avoid any chance of mistake, enable us to class definitely the medicament or indicate its real value as an antiseptic, if it has any value.

The finding of the therapeutic power of a given antiseptic is what Bouchard calls the finding of its *antiseptic equivalent*. "Thus far," says Bouchard, "experimenters have sought in general to establish the dose which prevents the germination of this and that microbe in one thousand grammes of culture broth. This is the antiseptic equivalent, a dose much inferior to that which kills the microbe, but superior by one-half, at least, to the dose which only retards its germination, and which is itself a dose useful in therapeutics."

The *toxic equivalent*, says Bouchard, is that proportion of a fatal dose of the antiseptic which corresponds to one kilogramme of body-weight in the animal under experimentation (for this quantity varies from one species to another). The toxic equivalent in man is determined by the same rule, but varies not only according to the weight of the person but also according to age, to sex, to accustomance, to the dis-

position of the moment, or even to individual idiosyncrasies. The knowledge of the toxic equivalent should follow that of the antiseptic equivalent.

Between these two equivalents, or by their side, we place the *therapeutic equivalent*, which interests us most in practice. To obtain this equivalent, Bouchard injects the medicament directly into a vein; whatever may be the amount injected up to the precise moment when *the first physiological effects* (dilatation of the pupil in the case of atropine, narcosis in the case of alcohol) appear, is the therapeutic equivalent. The digestive and the hypodermatic channels, although preferable in therapeutics, cannot give such precise results as the method by intravenous injection, as the stomach and the subcutaneous tissues absorb the medicament too slowly.

A great many experimenters have published the results of their researches on the comparative value of antiseptics, but most of them give only the *antiseptic equivalent* of the medicaments studied by them. Tables of this kind have been published, notably by Jalan de la Croix in 1881, by Miquel in 1883, by Bouchard and Tapret. We shall borrow from these tables valuable indications in the course of this work, and shall note under each medicament its antiseptic equivalent.

An important discovery resulting from experiments made on animals and on man, is this: The mixture of several antiseptics is more antiseptic than each of its components taken separately; the toxic power of the mixture is not augmented proportionally to its antiseptic power (Bouchard and Lépine).

MODE OF EMPLOYMENT AND INDICATIONS.

The antiseptics being once known, it is proper to

examine in what manner they should be used, a pathological case being given of which the diagnosis is well established.

And first, if we know the microbe which causes the disease, it is evident that we should employ as far as possible the antiseptic which is specifically active against this microbe. Thus it is that mercury and its preparations are employed against the supposed microbe of syphilis, cinchona and the salts of quinine against the micro-organism of malaria. So, also, experience has shown that creasote is particularly active against the bacillus tuberculosis, and iodoform against the microbes of suppuration.

But when there is an association of several microbes, or when we know of no specific for such as are present, or when, even, the species of micro-organism is unknown to us and we know only that *some* microbe is the causal agent, we are not necessarily disarmed in the presence of the disease. We know that the microscopic organisms, whether they belong to the vegetal or to the animal kingdom, are all more or less sensitive to the action of compounds which we designate under the name of antiseptics. The pathogenic bacteria, which all belong to the same general family (Bacteriaceæ), are particularly susceptible to antiseptics, and all are more or less hindered in their development by the action of energetic medicaments like corrosive sublimate. Their development is also retarded by the salts of quinine, although the latter are considered as specific only in malaria. While there may be reason, in a particular case, to make a choice among the antiseptics, we should not, in more obscure cases, allow ourselves to be checkmated because there is no antiseptic specifically appropriate for the disease, but should supply those

whose general antiseptic action is well known to us, or some eclectic admixture similar to that of Dr. Lépine.*

We should also distinguish between a *local* and a *general* antisepsis, and according to the circumstances we should attempt the one or the other, or employ both at the same time. In all cases there will be a choice to make, certain medicaments being more appropriate to local, and certain to general antisepsis.

By local antisepsis we understand *topical* antisepsis, such as can easily be effected when we have to do with disease or lesion of the skin or of the mucous membranes which line parts easily accessible (mouth, throat, vagina, etc.). Here most energetic antiseptics are sometimes indicated—*e. g.*, corrosive sublimate and phenic acid, medicaments that can hardly be utilized internally on account of their toxic action. The antisepsis of closed cavities, as of the pleura after paracentesis, should also be considered as local antisepsis.

General antisepsis is applied internally, whether by the stomach or by the subcutaneous method. When we give quinine for malaria, or mercury for syphilis, we perform general antisepsis, and it is probable that salicylate of soda acts in the same way in

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* ANTISEPTIC MIXTURE. (LÉPINE.)

	Grammes.
Corrosive sublimate	0.001
Phenic acid	0.10
Salicylic acid	0.10
Benzoic acid	0.05
Chloride of lime	0.05
Bromine	0.01
Hydrobromate of quinine	0.20
Chloroform	0.20
Distilled water	100.

acute rheumatism, whether this affection be microbic or not. The intravenous injections act much more rapidly than the hypodermatic, as Bouchard's laboratory experiments have shown; but this method is too dangerous for any but very exceptional cases of grave septic infection. *Per contra*, interstitial injections in the parenchyma of internal organs (as the lungs) have been made with success.

The antisepsis of the digestive tube takes a place between local and general antisepsis. In reality it is in most cases only a local antisepsis, and it is really this which we propose to effect when we give by mouth powdered charcoal, salicylate of bismuth, naphthol, etc. There is in these cases a demand for the exhibition of substances, such as those just mentioned, which are insoluble or nearly so in the gastric and intestinal juices; and very toxic compounds, such as phenic acid and corrosive sublimate, are to be employed in very feeble doses or not at all. Of the mercurial preparations, calomel and gray powder, as being relatively insoluble, are to be preferred.

PLAN AND DIVISION.

Most of the antiseptics actually in use being substances newly introduced into the materia medica, and consequently little known, it has seemed proper to commence by indicating their physical, chemical, and physiological properties before making known their therapeutic properties.

Part I will, then, be devoted to the study of antiseptics from a chemical, pharmaceutical, and physiological point of view; we shall indicate at the same time their antiseptic, therapeutic and toxic equivalents whenever these equivalents are known. We shall study separately the substances derived

from mineral or inorganic chemistry, and those furnished by organic chemistry, following the methodical order which agrees best with the properties of these substances.

Part II will be devoted to the clinical study of antiseptics. We shall examine separately each disease which demands antiseptic treatment. We shall give for these several diseases the therapeutic procedures and formulæ most in use, following the natural order of a treatise on internal pathology, and referring the reader to the First Part for every detail relative to the study of antiseptics considered in themselves.

Part III, much the shortest of the three, will be devoted to antiseptic hygiene, and more particularly to the hygiene of the sick.

PART I.

STUDY OF ANTISEPTICS FROM A CHEMICAL, PHARMACEUTICAL, AND PHYSIOLOGICAL POINT OF VIEW.

CHAPTER I.

ANTISEPTICS BORROWED FROM MINERAL OR INORGANIC CHEMISTRY.

GENERALITIES AND CLASSIFICATIONS.—Experience has shown that the most energetic antiseptics, that is to say, the chemical mineral substances which most efficaciously arrest the development of bacteria in general, are compounds of the noble metals, and are but little alterable in the air, such as mercury, silver, gold, etc.

"When you give a general glance," says Dujardin-Beaumetz, "over the tables given by Miquel, you cannot fail to note the high rank in the scale of antisepsis which is occupied by the noble metals, such as mercury, platinum, silver, and gold. In a rank a little below we must place the common metals, such as copper, iron, etc. To the third rank belong the alkaline earthy metals, and a fourth place must be assigned to the alkaline metals."*

Dujardin-Beaumetz, "New Medications," 2d Am. ed.' vol. i, p. 113.

When we come to the metalloids, we find that the greater or less of affinity which these bodies have for hydrogen seems to be an index of their antiseptic power. Chlorine, bromine, and iodine, which combine in equal volume with hydrogen, are energetic antiseptics; and chlorine, which unites directly with hydrogen under the influence of diffuse light, is more powerful than the two others, but its toxic power is proportional to its antiseptic power. These metalloids are called *halogen radicals.*

As for the salts, it seems that their antiseptic power, like their toxicity, is in inverse ratio to their abundance in nature, and, more particularly, in the tissues of living beings. The salts of potassium, of sodium, iron, etc.; which are active components of the tissues of man as of the animals and plants which serve for his food, and which by a natural consequence serve also for the food of the pathogenic microbes, are not toxic, while the salts of silver, of mercury, of copper, of lead, etc., which can hardly be said to be native to the organism, are toxic and antiseptic.

Another datum springing from the researches made on the microbicide power of mineral substances, is the great number of acids which are antiseptic, while the bases (ammonia, soda, potash, etc.) are but feebly antiseptic, notwithstanding the large doses employed.

This fact finds explanation in what we know of the way in which bacteria live. The cultures of the

laboratory show that these microscopic organisms can only thrive in nutritive media which are neutral or slightly alkaline, as are generally the culture broths. Only a very small number of microbes can develop in an acid medium.

"In a general way it may be said that acids added to culture broths are noxious to bacteria; yet the organic acids (tartaric, lactic, citric, acetic) oppose their reproduction less than the mineral acids. *The bases do not in general hinder their vegetation.* The fungi whose structure is more complex are, on the contrary, favored in their growth by the presence of acids, as is observed in fermentations."* Thus the *Saccharomyces albicans* or thrush fungus, which is not a true microbe or bacterium, but a fungus of the group of ferments, only develops in an acid medium. But most of the pathogenic bacteria will grow only in a neutral or alkaline medium; the microbes of diphtheria and Asiatic cholera belong particularly to this category.

If we examine particularly the different salts experimented with as antiseptics, we see that their efficacy depends both on the nature of the metal whose oxide or hydrate serves for their base, and on that of the body (generally a metalloid) which plays the rôle of acid in their composition. Hence, although the salts of potassium are in general very feeble anti-

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*Cornil and Babes, "Les Bacteries," 3d ed., page 39.

septics (we have given the reason why), compared especially with the salts of mercury or of silver formed with the same acids, still bromide of potassium is somewhat antiseptic by virtue of the bromine it contains—for in the organism, which contains chlorides, the bromine is partially or wholly liberated from the potassium. So also salts rich in oxygen, such as permanganate of potassium (K_2MnO_4), potassium bichromate ($K_2Cr_2O_7$) and chlorate ($KClO_3$), are all more or less antiseptic by reason of the large proportion of oxygen which they contain, and which they yield up readily to the organic matters with which they are put in contact. The chlorate acts, moreover, by the chlorine set free in this reaction. These are chemical properties which must be borne in mind when it is a question of explaining the action of an antiseptic.

It will be seen that the properties of these medicaments are, to a certain point, indicated by their chemical composition. It is, then, natural to study them in the order adopted by chemists, and this is the plan which we shall follow.

METALLOIDS.

Chemists divide the metalloids, according to their affinity for hydrogen, into four natural groups, which we shall study in the following order, confining ourselves to the bodies which interest us from the point of view of antiseptic medicine:

Group 1.—Chlorine, Bromine, Iodine, Fluorine.

Group 2.—Oxygen, Sulphur, Selenium, Tellurium.

Group 3.—Nitrogen, Phosphorus, Arsenic, Antimony, Bismuth.

Group 4.—Boron, Carbon, Silicum, Stannum.

HYDROGEN; WATER.

Hydrogen, which, by its characters, forms in itself a family apart, only interests us here as being a component of water (H_2O), which may be considered, especially from a hygienic point of view, as the simplest and most general of the antiseptics employed externally. It is also the solvent and vehicle of a great number of antiseptics used internally and externally. But bacteriological researches have shown how necessary it is that the water employed, not only as a beverage, but for the needs of cleanliness, and above all for medical use, should be absolutely free from all microbes.

The greater number of pathogenic microbes live very well in water, and the contagion of typhoid fever by drinking-water is a fact considered as proved. It is probable that a very great number of other pathogenic microbes may be introduced into the organism in the same way. We shall not insist upon this point, but we shall indicate how it is possible to procure water free from microbes.

Aseptic Water.—Heat carried to the boiling-point, and filtration, are the principal means employed for

purifying water to render it aseptic. The water is made to boil for about a quarter of an hour, and is then turned into a vessel communicating with a Chamberland filter; after filtering, it is collected in receptacles, which may be of glass, in the shape of little barrels placed upright, with a capacity of six to ten quarts each, and provided with a tap at the lower part. Boiling is not indispensable, the filtration through the Chamberland filter being sufficient. All pharmaceutical solutions should be prepared with water thus purified.

Great use has been made of water in surgery in the treatment of wounds. Recall the *continued irrigation*, in use twenty-five years ago, which acted at once as a refrigerant and as an antiseptic, carrying away the microbes with the products of suppuration, and continually *washing* the wound. In 1870 we saw applied in the field-hospital of the *Comédie Française*, during the siege of Paris, the *tepid bath* treatment as the sole treatment of gun-shot wounds, and this practice gave very satisfactory results. Some surgeons still recommend irrigation of amputated stumps and recent wounds (Reclus). But this method is generally abandoned to-day for the antiseptic dressings properly so called—closed dressings, which are at once more sure and more rapid. Irrigations and pulverizations of antiseptic solutions are very much in use.

Ice, like the water from which it is derived, co

tains microbes. Ice used in therapeutics should be strictly limited to that which comes from water filtered through the Chamberland filter.

CHLORINE.

A metalloid, gaseous at the ordinary temperature, of a greenish-yellow color, suffocating odor, caustic taste, unfit for respiration, and deleterious. One quart of water dissolves two quarts of chlorine, at the temperature of 156° to 20° C. (312° to 68° F.). It is in this form that it is employed in medicine.

Gaseous chlorine, according to Jalan de la Croix, is one of the most powerful germicides: it ranks, under this head, immediately after corrosive sublimate; one gramme of gaseous chlorine dissolved in 30 litres of water arrests the development of bacteria in a culture broth.

Notwithstanding this fact, chlorine cannot be employed internally, on account of its irritant action. Breathed in the gaseous state, it provokes cough, suffocation, and spitting of blood. It is difficult to understand why it was formerly recommended for diseases of the bronchi and even for phthisis.

On the other hand, chlorine is one of the best antiseptics that can be employed to disinfect garments and buildings. We shall return to this subject in treating of *antiseptic hygiene*.

Hypochlorite of lime ($CaCl_2 + 6H_2O$), or calcium chloride, which owes its properties to both oxygen

and chlorine, does not so affect microbes unless in treble the quantity (3 grammes to 30 litres). It is a white powder, with strong odor of chlorine, eagerly absorbs moisture, but is only partially soluble in water. The solution of the Codex (liquid calcium chloride) is $\frac{1}{45}$. It is rarely used except externally. According to Cornil and Babes, a 5-per-cent. solution of this salt requires ten days to kill bacteria. Gaseous chlorine must, then, be preferred to it, particularly for the disinfection of apartments.

Chlorate of potassium ($KClO_3$) is a white salt soluble in 17 parts of water at 15° C., and in 30 of glycerin, insoluble in alcohol and ether. It acts as an oxidizing agent upon organic matters on account of the three equivalents of oxygen which it contains, which also give it a great tendency to unite with hydrogen. It is employed in the treatment of stomatites: it is eliminated in part by the salivary glands. Its toxic equivalent (the fatal dose for one kilogramme weight) is 16 centigrammes of a $\frac{1}{100}$ solution, while its antiseptic equivalent is insignificant. It acts only as a disinfectant.

Chlorate of sodium, soluble in 3 parts of water, appears to have the same properties as the above, but its toxic equivalent is much more feeble. This is evident when the salts of sodium are compared to the salts of potassium, and is to be accounted for by the fact that sodium is a much more common constituent than potassium of animal organisms; the contrary is the rule in plants.

Hydrochloric acid (HCl) is the product of the direct union of chlorine and hydrogen, which takes place very readily, under the influence of diffused light, when a volume of chlorine and hydrogen are brought together. It is a colorless gas, of strong odor, pungent, irrespirable, and has great avidity for water, as is shown by the fumes which it produces in the air when it combines with vapor of water.

Water dissolves, at 20° C., 464 times its own volume of this gas. It is this saturated solution which constitutes the hydrochloric acid employed as a reagent in laboratories. The acid of commerce contains only 36 to 37 per cent. of the gas. It produces eschars upon the skin and mucous membranes.

This acid is *strongly* antiseptic (Miquel) in the dose of 2 to 3 grammes; the same may be said of the other mineral acids, sulphuric, nitric, and phosphoric.

The solution (2 to 4 grammes per litre of water) is used for gargles and for a refrigerant beverage.

Several drops of this acid added to solutions of corrosive sublimate or phenic acid increase their antiseptic properties (Laplace).

Fumigations of hydrochloric acid have been recommended, since the end of the last century, as disinfectants, by Guyton-de-Morveau.

The chlorides will be studied with their metals, and the organic compounds of chlorine (chloral, chloroform) in the following chapter.

BROMINE.

Bromine is a reddish-brown liquid, giving off red fumes when exposed to the air, the disagreeable odor of which resembles at once that of both iodine and chlorine. It is but slightly soluble in water (3 per cent.), very soluble in alcohol and ether.

It is an irritant caustic of almost instantaneous action; but as, on the one hand, its antiseptic equivalent is superior to that of iodine, and, on the other hand, it is easier to manage than chlorine, it should be preferred to those two bodies, whose general properties it possesses; care must be taken not to use it except in very dilute doses.

Its antiseptic equivalent places it in the sixth rank after corrosive sublimate (Jalan de la Croix). A solution of $\frac{1}{6308}$ arrests the development of bacteria. It also prevents, in very weak doses, the action of soluble ferments (emulsin, ptyalin, diastase, etc.), and it might be employed to advantage against the poisons of microbic origin which have the constitution of diastases.

These antiseptic properties might suffice to restore to popularity a medicament too much neglected to-day. Ozanam showed in 1869 its utility in dissolving diphtheritic false-membranes (in solutions of $\frac{1}{500}$ or $\frac{1}{1000}$). He also employed fumigations of bromine water. More recently it has been used together with bromide of potassium, in equal parts

($\frac{1}{200}$ or $\frac{1}{400}$ of each in watery solution), for swabbings and inhalations (Hiller).

Bromides.—The bromides of *potassium*, *sodium*, *strontium*, have been used as less toxic succedanea of bromine. But these salts are much less antiseptic than the metalloid from which they are derived, and act only in strong doses (Miquel ranks them among the *very feebly* antiseptic substances, while bromine is very strongly so).

Dr. Peyraud (of Libourne) has used with success insufflations of pulverized bromide of potassium for diphtheritic angina.

Bromal, *bromoform*, and *bromhydrate of quinine* are organic compounds of bromine which will be studied in their proper places.

IODINE.

Iodine is solid at ordinary temperatures, fusible at 110° C., and but slightly soluble in water ($\frac{1}{7000}$ at 10° C.), but it is soluble in alcohol, chloroform, benzine, carbon bisulphide, ether, fatty bodies, glycerin, and vaselin. It combines with hydrogen only at red heat, but decomposes hydrogen sulphide by taking away its hydrogen. It is an irritating agent, caustic, colors the skin yellow, and produces local inflammations in contact with the mucous membranes.

The tincture of iodine of the Codex consists of one part iodine to twelve of alcohol. It is well to remember that the tinctures of the foreign pharma-

copœias are often much more concentrated, and consequently more active. The French tincture of iodine itself varies very greatly in this respect when it has been prepared for a long while and kept in badly stoppered flasks. The addition of a certain quantity of iodide of potassium permits dilution of the tincture with water without precipitation of the iodine.

The action of iodine as a disinfectant was indicated long ago by Boinet (1840). Later (1863), O. Réveil showed that it would neutralize the action of viruses and venoms (in solutions of 5 per 100); Wernitz (1880), that it has the same effect on soluble ferments (in solutions varying from $\frac{1}{1000}$ to $\frac{1}{15000}$). According to Jalan de la Croix, a solution of $\frac{1}{40}$ sterilizes all the spores of bacteria. Royer and Davaine have shown the power of the tincture of iodine on the virus of glanders and on that of charbon (solution of $\frac{1}{150000}$).

Iodine may be used internally in doses of one to five centigrammes per day. As a gargle or collutorium, a mixture of tincture of iodine and glycerin with a little iodide of potassium is often used. In empyema and hydrocele, after having withdrawn the liquid by tapping, the surgeon injects an aqueous solution of iodine and iodide of potassium.

The *iodides* of potassium, of sodium, of strontium, etc., have a very weak antiseptic power, while the biniodide of mercury, the iodide of silver, and the iodide

of cadmium are very strongly antiseptic (Miquel). The first two occupy even the first and second place in the table given by Miquel. They are antiseptic in quantities respectively of 25 and 30 milligrammes to a litre of beef bouillon exposed to the contagion of microbes of the air, while bichloride of mercury is antiseptic only in quantities of 70 milligrammes to the litre. The iodide of sulphur has been used by Galtier for chronic glanders.

The eminently antiseptic properties of chlorine, bromine, iodine (mono-atomic metalloids), and of compounds formed by their union with the noble metals or the earthy-alkaline metals (cadmium belongs to the same group as zinc), may be explained by their chemical properties. It is known that the chlorides are powerful oxidizers of organic matters—a property which they owe to their great affinity for hydrogen, which always enters into the composition of these latter. The iodides and bromides have analogous properties: *in presence of an oxidizable body they split up, and act at once by the metalloid and by the metal*, set at liberty in the nascent state, which enter into their composition; it is this which explains why the iodides of mercury, silver, and cadmium are much more antiseptic than those of potassium, sodium, etc. The first are easily decomposed in the organism, while the last are found* unaltered in the urine.

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*It is well to remember that the alkaline chlorides normally exist in the organism and in our food (muscular juice, etc.).

However this may be, when use is made of these very active bodies it must always be remembered that their action is exerted on the cells of our organs as well as on microbes, and that consequently they ought not to be used except in very weak doses and in a very dilute form.

FLUORINE; HYDROFLUORIC ACID.

Fluorine is a metalloid belonging to the same group as the preceding, and presenting similar properties, but difficult to isolate, and known only by its salts—which resemble the chlorides, and from which it has been possible to isolate the acid.

Hydrofluoric acid (obtained from *fluor spar* or *fluoride of calcium*) is a colorless liquid, mobile, boils at 15° C.; the fumes are very corrosive, producing blisters on the skin followed by very painful wounds. It is used in the arts only, in very dilute solutions.

The experiments conducted by MM. Dujardin-Beaumetz, Hayem, Thompson, Chevy, have proved, contrarily to the affirmations of M. Grancher, that hydrofluoric acid is a powerful antiseptic, meriting a place near biniodide of mercury. In the proportion of about 1:20000 it will kill the bacillus of tuberculosis (H. Martin).

Hydrofluoric acid, mixed with atmospheric air (1 to 200), has been recommended by M. Seiler as an inhalant in pulmonary tuberculosis. It acts by arresting the development of bacilli (Trudeau).

OXYGEN; OZONE; AIR.

With *oxygen* we take up the second group of metalloids, which includes sulphur, selenium, and tellurium—bodies not mono-atomic like the preceding, but diatomic with respect to hydrogen. They do not combine with it volume by volume, like chlorine and iodine; but one volume of oxygen, for instance, combines with two volumes of hydrogen, and the whole is condensed to two volumes instead of three. But this combination is effected with some difficulty, for two volumes of hydrogen and one of oxygen brought together will not combine to make water except under the influence of the electric spark or an elevated temperature (by the setting on fire of the hydrogen). The metalloids of this group have, then, much less affinity than the preceding for hydrogen, which explains their feebler antiseptic power.

Oxygen, the active component of atmospheric air, is an antiseptic of great importance.

Pasteur has shown that microbes, notably that of fowl cholera, lose their virulence under the influence of the oxygen of the air; cultures dating from fifteen days, one month, two months, eight months, ten months, lose progressively their toxic power. Koch admits also that the action of the air and the desiccation of the germs effect, at the end of a certain time, the natural extinction of an epidemic. Finally, the experiments of P. Bert and M. Regnaud have shown that oxygen kills bacteria, but only at high pressure.

The therapeutic applications based on these notions are numerous. The sojourn of the tuberculous in the country or in elevated localities where the air is renewed often; the treatment by *open windows* night and day, in all seasons (Debove); aërotherapy by compressed air charged with antiseptic substances (creasote, guaiacol, terpinol, etc.); all these therapeutic processes have for their end to apply the action, at once antiseptic and stimulant, of air—that is to say, of oxygen.

The manufacture of oxygen in portable apparatus, for medical and other purposes, is to-day assured, and the profession can easily be provided with large enough quantities for all therapeutic uses. It is kept in store in compressed form, and when the physician desires to administer it it is decompressed in order to be mixed with atmospheric air and the various antiseptic vapors. Oxygen is too excitant a remedy to be used pure. Compressed air—that is, mitigated oxygen — charged with certain medicinal vapors, is set free in hermetically closed rooms or bell-shaped receptacles. Here the patients are made to stay from one to two hours or more, while the medical attendant slowly compresses or decompresses the gaseous mixture which they breathe. This *aërotherapy* is employed in tuberculosis, whooping-cough, chronic bronchitis, etc.

Oxygenized water or *binoxide of hydrogen* (H_2O_2) is a definite chemical compound which must not be

confounded with the oxygenized water ordinarily sold in syphons; the latter is nothing but oxygen mixed with ordinary water at high pressure, like carbonic acid in Seltzer water. Both, however, may be used for the same purposes. The chemical oxygenized water (H_2O_2) is a ten-volume solution, diluted with the same quantity of pure water to render it non-irritant. According to the researches of M. Desmoulins,* this is but a middling antiseptic. In reality it acts primarily as a disinfectant in oxidizing organic matters by the setting free of the oxygen which it contains.

Ozone is an allotropic modification of gaseous oxygen, obtained under the influence of the electric spark. Its properties closely resemble those of oxygenized water; but instead of being administered by mouth, as is most convenient with oxygenized water, it is adapted to direct application to the lungs by inhalation. It is generally admitted that ozone is condensed oxygen (O_3), but it is hardly known except in the form of ozonized oxygen—that is, mixed with an excess of oxygen.

Ozone possesses the property of oxidizing, at the ordinary temperature, bodies upon which oxygen itself has no effect; this it is which has given ozone its reputation as an antiseptic. Apparatus specially designed to produce ozone have recently been constructed, for the purpose of enabling patients to

* Thèse de Lyon (1887).

breathe ozonized air or oxygen, which acts at once as eusthenic and antiseptic.

SULPHUR.

Sulphur is one of the most common metalloids in nature, and is to be found both pure and in combination. In medicine it is principally used under the form of *flowers of sulphur*, freed from impurities, and employed as a pomade in diseases of the skin. It destroys the lower organisms (fungi, parasites, acari, etc.). It is rarely used internally as an antiseptic.

Hydrogen sulphide, or sulphuretted hydrogen (H_2S), also exists in nature, notably in sulphur waters. It is produced by the putrefaction of organic matters, and traces of it are found in atmospheric air. It is the major constituent of the toxic gases of cesspools and privies. It is easily absorbed, not only by the lungs, but also by the skin and mucous membranes. The sulphur waters have been recommended in the treatment of tuberculosis and of chronic bronchitis.

The alkaline sulphides are classed by Miquel among the substances *strongly* antiseptic.

Calcium sulphide has been used internally with success in the treatment of diphtheritic anginas (one to ten centigrammes and more, in fractional doses). In the stomach it is probably decomposed, setting free hydrogen sulph[illegible] the breath of patients to whom it is administ[illegible] of *rotten eggs;*

and it is the sulphuretted hydrogen thus set free which gives thiis salt its antiseptic properties. It is used externally as an antipsoric.

Sulphurous acid (SO_2) is a gas produced by the combustion of sulphur in the air. It is an energetic antiseptic—Jalan de la Croix gives it the fourth place, after corrosive sublimate and chlorine—but it destroys only the bacteria which are on the surface of objects; it has no effect when the parasites are not exposed. Diffused through the air of a room in the proportion of 1 per 100, this gas will disinfect the walls, but the spores are not destroyed (Cornil and Babes).

Sulphuric acid (SO_3), which is found in commerce only in the form of Nordhausen's sulphuric acid ($SO_3+H_2SO_4$), or *oil of vitriol*, shares the properties of sulphurous acid, from which it is derived. Miquel classes it among the *strongly* antiseptic bodies. But its avidity for water, which is probably one of the principal causes of its germicidal action, makes it very difficult to manage. It is very caustic, taking away from organic substances both oxygen and hydrogen in the proportions necessary to form water; it disorganizes and ulcerates the skin and mucous membranes. It must only be used internally in a state of great dilution.

Nearly all the *sulphates* have marked antiseptic properties. Copper sulphate occupies the first place; its equivalent is 90 centigrammes per litre, an equiva-

lent superior even to that of its acid, and Miquel classes it among the substances *very strongly* antiseptic. Then comes nickel sulphate, strongly antiseptic (equivalent, 2.50 grammes). The sulphates of strychnine, of iron (moderately antiseptic), and of ammonia, and the hyposulphite of soda (very weakly antiseptic) act only in very much stronger doses.

Selenium and Tellurium, as well as their compounds, have no use in medicine.

NITROGEN.

Nitrogen, phosphorus, arsenic, antimony, and bismuth form a third group of metalloids possessing similar properties: all are triatomic, combining with three atoms of hydrogen or of chlorine.

Nitrogen gas mixed with oxygen in atmospheric air appears to serve only as a diluent. In its purity it is irrespirable, but this is simply because of the lack of oxygen, for it is not toxic. Attempts have been made of late to utilize it in therapeutics, although its physiological action is not well known. Nor is its action on pathogenic microbes any better known:* on the aërobic it acts by deprivation or diminution of oxygen; it has no effect upon the anaërobic. It is well to remember that nitrogen exists in a state of combination more or less complex in most of the tissues and liquids of the organism.

* We shall see later that the presence of nitrogen in an organic combination *lowers* (otl
tiseptic power.

Nitrogen has been used for inhalations in febrile diesases to diminish the organic exchanges and consequently the temperature (Valenzuela, of Madrid). Nitrogenized waters, natural or artificial, have been administered in sprays for the same end, in Germany and Spain. No definite results have been obtained.

Nitric acid (HNO_3) is liquid, giving off white fumes in the air. It is a very powerful oxidizing agent and a caustic which decomposes organic matters, coloring them yellow. As an antiseptic it has the same equivalent as the other acids, and does not offer any advantage over sulphuric acid. Like the latter, it must only be employed in very dilute form internally, unless the physician desires to avail himself of its local caustic action, as in endometritis, where the indication is to destroy a diseased mucosa.

The *nitrates* used in medicine are, first, nitrate of silver, which may be considered as one of the most powerful antiseptics known (it occupies the fifth place in the table of Miquel; its antiseptic equivalent is 0.08 gramme, being nearly equal to that of bichloride of mercury). In contact with organic matters, silver nitrate is decomposed into metallic silver, nitric acid, and oxygen, *i. e.*, three more or less antiseptic bodies; this it is which explains its powerful action. But this action can hardly be utilized except externally; internally it is a violent poison even in small doses (the physician should never exceed doses of one to five centigrammes).—Acid nitrate of mercury is employed

as a caustic externally.—Bismuth nitrate owes its properties to the metalloid from which it is formed, and will be discussed further on.—Potassium nitrate (or nitre), and the other alkaline nitrates, appear to be without antiseptic properties.

Gaseous ammonia (NH_3) is classed by Miquel among the substances strongly antiseptic (equivalent, 1.40 grammes).

PHOSPHORUS.

Phosphorus, as is well known, exists in two allotropic states: the white, or ordinary, and the red phosphorus. The latter is not toxic, but the first is a violent poison. This essential difference is due to the ready solubility and oxidation of the white phosphorus as compared with the red. Phosphorus, in the metalloid state, has not been used as an antiseptic. As for *phosphoric acid*, it has the same general properties as the other acids, but is little used. Phosphorus exists in the organism in the state of alkaline phosphates.

The *phosphate of copper* is the only phosphate that has been used as an antiseptic in tuberculosis (Luton, of Rheims).

The phosphates and hypophosphites of calcium act only as eusthenics (tonics and reconstituents).

ARSENIC.

Arsenic and its salts have properties which resemble those of phosphorus. When arsenic is em-

ployed internally, as in intermittent fevers, it is probable that it acts as a eusthenic (by modifying the circulation), and not as an antiseptic after the manner of the salts of quinine. Warrikoff, of Dorpat (1883), has noted that arsenious acid does not destroy bacteria. Yet Miquel ranks arsenious acid (antiseptic equivalent, 6 grammes [!]) among the substances "moderately antiseptic."* In this dose arsenious acid would be a violent poison for man, since doses of ten *milligrammes* per day cannot be exceeded without danger.

ANTIMONY.

From a chemical point of view, antimony much resembles arsenic. This metalloid, which had such a great reputation in antiquity, in the Middle Ages, and even in the first half of this century, is to-day nearly abandoned. *Tartar emetic* (double tartrate of antimony and potassium) is used now only as an emetic or emeto-cathartic. This is not the place to speak of the "contra-stimulant" or antiphlogistic action of this salt. It does not appear to have microbicide properties, while its action upon the organism is very energetic and ought to be carefully watched. The same is also true of *kermes* (a mixture of oxide and sulphide of antimony) and of *white oxide* of antimony.

BISMUTH.

Bismuth, although belonging to the same group

* It has been used in embalming.

as the preceding, differs in several points, and forms a little group by itself. Its combinations with oxygen ally it closely to the metals. Its salts have very different properties, and several are actually much used in antiseptic therapeutics.

Bismuth was employed formerly only in the form of the *nitrate* or *subnitrate*, which is very slightly toxic, being insoluble in water and very slightly soluble in the stomach, while the soluble salts (citrates, tartrates) are toxic and produce tetanic paroxysms (contractures, arrest of respiration and of the heart). The subnitrate, resisting solution in the alimentary canal, exerts a purely physical action as an absorbent of liquids and gases. It acts in the same manner upon superficial wounds. It is, therefore, only an indirect antiseptic.

The salicylate of bismuth will be studied with the other compounds belonging to organic chemistry. Note, for the present, that it is insoluble, or slightly soluble, like the nitrate.

BORON.

Boron, carbon, silicium, and stannum form the last group of triatomic or tetratomic metalloids. Stannum, by its characters, forms the transition from metalloids to metals.

Boron is found in nature in the state of *boric acid* or of *borax*, notably in the lakes of Tuscany and in a great number of mineral springs. Boric acid and

borax have both been used for many years in medicine.

Boric acid is solid, crystallizable in transparent colorless plates, soluble in cold water (1 to 25), much more soluble in warm water; soluble in five parts of glycerin and in sixteen parts of alcohol at 90° C. It is but slightly toxic—25 grammes was on one occasion swallowed by a sick person without poisonous effects.

The antiseptic power of boric acid is really extremely weak; Miquel ranks it among the substances *moderately* antiseptic (equivalent, 7.50 grammes); but its therapeutic value is greatly enhanced by its extreme innocuousness. It is much used, either alone or associated with other more powerful antiseptics.

Boric acid prevents fermentation and putrefactions; it retards the development of bacteria without killing them. In the form of powder it is more active than in solution, though a saturated solution of $\frac{4}{100}$ is sufficient to arrest the harmful action of pathogenic microbes.

To obtain concentrated solutions of boric acid (solutions exceeding 4 per cent.), magnesia or the carbonate of magnesia is added. M. Puaux indicates the following formula:

Boric acid	100
Magnesium carbonate	14
Water	1000

Mix and gently warm.

This solution, which is of specific gravity 1.044, of acid reaction, is stable, and contains 100 grammes of boric acid to the litre, *i. e.*, is more than double the strength of the ordinary solution.

It is possible to prepare a solution of even greater strength—of 20 per cent.—and of a specific gravity equaling 1.088, by means of the following combination:

Boric acid	200
Magnesium carbonate	35
Water	1000

But a still better result may be obtained by using the tetraborate of sodium recently introduced into therapeutics by Jaenicke. This salt dissolves in cold water in the proportion of 16 per 100, and in warm water in almost any proportion (50 and 60 per 100).

Borax, or *borate of sodium*, is soluble in twenty-two parts of water, two of glycerin, and is insoluble in alcohol. Its antiputrid properties have long been known (Jacquez, 1856). Dumas (in 1872) showed that solutions of this salt will arrest alcoholic and diastatic fermentations, etc., and the digestion of fibrin by pepsin.

Borax is a weaker antiseptic than boric acid. Miquel classes it among the substances *weakly* antiseptic, and gives it an equivalent of 70 grammes, which indicates that it is four or five times less antiseptic than its acid. It [illegible] the germs torpid, but does not destroy the[illegible]ne their activity when they ar[illegible]dium.

CARBON AND CARBONIC ACID.

Carbon is used in therapeutics in the form of charcoal only. A great number of bodies (phenols, etc.) are extracted from coal or fossilized carbon; and their study, like that of the greater number of carbon compounds, belongs to organic chemistry.

Carbonic acid gas, which is always present in atmospheric air, as a product of animal respiration, does not accumulate there, owing to plants which decompose it, fixing the carbon in their tissues and setting free the oxygen in the air. This gas is irrespirable, and, in proportions of 10 or 20 per cent., renders a confined atmosphere deleterious for man and animals.

Attempts have been made to utilize carbonic acid in therapeutics, and it has even been tried in pulmonary tuberculosis! None of the well-known physiological effects of this gas appear to belong to the domain of antisepsis.—Remember that certain anaërobic microbes (butyric and septic vibrios of Pasteur) live in pure carbonic acid, in nitrogen or hydrogen, and are killed by oxygen.

Liborius has drawn up a table of the principal bacteria in the order of their greater or less affinity for oxygen;* but there are many which live as well without air as in the air; such are those of pneumonia,

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*Cornil and Babes, "Les Bactéries," 3d edit., vol. i, p. 131.

etc. Application has not yet been made of these data to the therapeutics of microbic diseases; but what we thus far know does not seem favorable to the employment of carbonic acid as an antiseptic.

Carbon protoxide must not be confounded with carbonic acid; it is much more deleterious than the latter, for it combines with the hæmoglobin of the blood-corpuscles, destroying it and rendering it unfit for hæmatosis. This toxic gas is formed when carbon is burned at a high temperature in the presence of a quantity of oxygen insufficient to transform it into carbonic acid, or when the latter is decomposed by bodies capable of taking away its oxygen. A dog will die in air containing $\frac{1}{250}$ of its volume of this gas, and a man would be poisoned, especially during sleep, by a much smaller dose. It has been used as a local anæsthetic.

The sulphide of carbon will be studied with the organic compounds of carbon.

Silicium and Stannum, and also their salts, are without use in antiseptic therapeutics.

METALS.

The metals are monoatomic or diatomic, with the exception of gold, which is at once mono- and triatomic, and platinum, which is di- and tetra-atomic. They are divided into groups in the following manner:

First group.—Potassium, Sodium, Rubidium, Lithium.

Second group.—Ammonium.

Third group.—Silver (always monoatomic).

The following are diatomic :

Fourth group.—Barium, Strontium, Calcium.

Fifth group.—Plumbum (lead).

Sixth group.—Magnesium, Zinc, Cadmium.

Seventh group.—Copper, Mercury.

Eighth group.—Iron, Chromium, Manganese, Nickel, Cobalt.

Ninth group.—Aluminium.

Tenth group.—Gold (mono- and tri-atomic).

Eleventh group.—Platinum, Osmium (di- and tetra-atomic).

This table shows that the atomicity has not a capital importance from an antiseptic point of view, at least when metals and their inorganic salts are concerned, since powerful monoatomic antiseptics exist, as silver; others are diatomic, as mercury; others still, triatomic, as gold; or tetratomic, as platinum.

POTASSIUM; SODIUM.

These two metals exist in the organism in the form of potash, soda, and combinations with chlorine. The salts of soda predominate; but, as our food (meat, bread, etc.) contains salts of potassium in greatest quantity, we need additions of common salt (sodium chloride) to preserve the physiological balance.

The salts of potassium are, moreover, toxic in doses in which the salts of sodium produce no harmful effects or are merely purgative. Thus, 8 grammes of potassium sulphate produce the same purgative effect as 30 grammes of sodium sulphate; in the latter dose, potassium sulphate would be toxic. According to Miquel, potassium iodide, potassium bromide, and sodium chloride have but a very weak action on bacteria, as the enormous doses which must be employed indicate (antiseptic equivalents, 140, 240, and 165 grammes).

Potassium cyanide, which is strongly toxic and strongly antiseptic, owes its properties to hydrocyanic acid. Likewise the *bichromate* ($K_2Cr_2O_7$), the *permanganate* ($K.2MnO_4$) and the *chlorate* of potassium ($KClO_3$), which are more or less *strongly* antiseptic, owe this property, as has already been said, to the large proportion of oxygen which they contain and which they easily yield to organic matters.

Potash and soda are caustic; the first enters into the composition of *Vienna paste*. The sulphides of potassium and sodium act in the same manner as hydrogen sulphide, and are toxic in larger doses than a few centigrammes. The base, however, has no effect on their antiseptic action.

These considerations are sufficient to show that the salts of potassium and of sodium are, with the exception of the bichror he permanganate (oxidizing agents ac nfectants), poor antiseptics.

Lithium and Rubidium furnish no antiseptic compound.

AMMONIUM—AMMONIA.

Ammonia gas (NH_3) is considered by chemists as the hydrate of a metal (NH_4) designated by the name of *ammonium*. The ammoniacal salts have indeed much resemblance to those of the alkaline metals, and we may at once conclude that they are feebly antiseptic. This is what direct experience shows.

The gas ammonia, which is a very violent irritant poison to the organism, is of itself strongly antiseptic. But in the form of solution (liquor ammoniæ), this base acts as a caustic and can hardly be used except to cauterize venomous wounds.

Ammonium chloride (sal ammoniac) is only feebly antiseptic, in the enormous dose of 115 grammes.

SILVER (ARGENTUM).

Silver is the only monoatomic metal which is a good antiseptic. It acts upon microbes, even in the metallic state, despite its relative unalterability. It has been stated that the lower vegetable organisms cannot grow in a silver vessel (Cornil and Babes). The silver salts are toxic when given internally in larger doses than ten to twenty centigrammes.

Iodide of silver is, as has already been said, a powerful antiseptic, coming immediately after the biniodide of mercury in the table of Miquel. Its anti-

septic equivalent is 30 centigrammes, but it is not much used—the biniodide of mercury being generally preferred.

Nitrate of silver is the sole compound of this metal which is used in medicine. It is a powerful antiseptic, occupying the fifth place in the list of Miquel (equivalent, 8 decigrammes).

This crystallized salt is soluble in water, glycerin, and alcohol. It is chiefly used externally, notably in the treatment of ophthalmias of microbe origin. The relative innocuousness of this remedy when used, and the ease with which its action may be limited by neutralizing all excess of the salt with a solution of sodium chloride (which produces an insoluble chloride of silver), renders it of great practical utility, especially when a rapid action (which may be repeated as often as necessary) is desired. Nitrate of silver may be melted and run into moulds; in the form of a pencil or crayon it is used as a caustic.

CALCIUM; BARIUM; STRONTIUM.

These three diatomic metals, closely related by the nature of their salts, present great differences in respect to their action on the organism. The salts of barium are very poisonous, while those of calcium and of strontium are not more so than the salts of the alkaline metals.

We know that the salts of calcium are present in the organism (muscles, blood, bones) and in the

greater part of our foods (meat, bread, etc.). It may be concluded that these salts are not antiseptic, and experience indeed shows that *calcium chloride*, in spite of the presence of chlorine, is a *weak* antiseptic (equivalent, 40 grammes, according to Miquel).

Lime-water, which is employed in medicine, is alkaline, and, according to what we know of the action of alkalies, cannot be considered as an antiseptic. It acts only upon the lower fungi which, like the thrush plant (*Oidium albicans*), thrive in an acid medium.

We have already spoken of calcium sulphide, which acts, as do all the sulphides, by setting free hydrogen sulphide.

The *acid iodate of calcium* has been found to be an energetic antiseptic, not surpassed by anything but corrosive sublimate; it is at the same time harmless when taken internally (Klein).

The *iodide* and the *bromide of strontium* have been used, during the past few years, for the same purposes as the corresponding salts of potassium.

According to what we know of the toxic action of the salts of barium, one might be surprised to see *chloride of barium* classed among the *weak* antiseptics (Miquel) with an equivalent inferior even to the chloride or hypochlorite of calcium. The researches of M. Charles Richet confirm this surmise. Baryta is, however, caustic, but does not offer any advantage over potash. It has been known for a long time that the salts of barium arrest the germination

of seeds (De Candolle). It would appear that they do not act except in very large doses upon the lower vegetal organisms of the group of bacteria. The iodide and the chloride of barium have been employed externally with success, as anti-scrofulous medicaments.

To sum up, the salts of barium are believed to act upon the organism as paralyzers of the heart, and muscular stimulants, but not as antiseptics (Boehm).

LEAD.

The salts of lead are toxic to man, and seem to have been studied but little from the point of view of their action upon microbes.

The *iodide* of lead, used externally (for scrofulous and syphilitic swellings), probably acts chiefly by the iodine which it contains.

Lead *carbonate*, in solution in oil, has been recommended by English physicians as a good topical agent in erysipelas. It acts probably as the other preparations of lead (acetate, binoxide, tannate), as a siccative and an astringent, and its action on microbes consists in depriving them of the water which they require.

MAGNESIUM; ZINC; CADMIUM.

Magnesium exists in the organism with lime in the state of a phosphate; it is found also in the greater part of our foods. Hence the salts of magnesium are neither toxic nor antiseptic.

It is not so with *Zinc* and its salts. After mercury, gold, platinum, silver, zinc is, of all the common metals, the one which holds the first place in antisepsis—even before copper (Richet). The salts of zinc are poisonous in doses exceeding one gramme. It is well known that zinc vessels are unfit for cooking purposes, as water, wine, milk, and oil attack this metal.

Zinc chloride is considered as *strongly* antiseptic, but it probably owes its germicidal properties in a great measure to the chlorine it contains (equivalent, 1.6 grammes, according to Miquel). It is soluble in water and alcohol (*Burnett's solution* used in England). Being inodorous and comparatively cheap, it is used to disinfect hospital wards (solution 1:50), the holds of vessels, sewers, and water-closets (1:100). In medicine it is seldom used except externally as a caustic; solutions of 1, 5, 8 and 10 per cent. have been used as a dressing for ill-conditioned wounds and fistulas.

Zinc sulphate is also a good antiseptic (Jalan de la Croix)—inferior, however, to copper sulphate, but less caustic. It is employed in vaginal injections (Ricord) and in collyria.

Zinc sulphite, recommended by Henston and Tichborne, is a non-toxic and non-irritant antiseptic. An antiseptic gauze is prepared by saturating the material with this salt, and keeps a long time without alteration.

Zinc iodide, a very active compound, little used internally on account of its emetic and toxic action, is employed externally as a pomade.

Zinc oxide, mixed with corrosive sublimate (60 grammes to 6 decigrammes of the latter), is a good antiseptic, resembling in its properties iodoform (Benjamin). The oxide must be heated to 200° and, after cooling, mixed with corrosive sublimate.

The salts of *Cadmium* appear to have a toxicity and properties similar to those of the salts of zinc.

The *iodide of cadmium* is very strongly antiseptic (equivalent, 50 centigrammes, according to Miquel). It has been used in ointment.

Cadmium sulphate has been used in the place of zinc sulphate for collyria and in injections for blennorrhagia; its use appears to present advantages, at least in acute cases.

COPPER; MERCURY.

The salts of *Copper* are very poisonous, and are at the same time energetic antiseptics. *Copper chloride* ($CuCl_2 + 2H_2O$) and *copper sulphate* are *very strongly* antiseptic (Miquel), with equivalents of 70 and 90 centigrammes.

The *acetate* and the *phosphate* of coppe nascent state have been recommended b tuberculosis. The *acetate* of copper used as an escharotic to destroy rebelli and vegetations of syphilitic origin.

Copper *sulphate* is more commonly used in solution, for external use, as an antiseptic or disinfectant, notably in discharges of uterine origin (Charpentier). The one-per-cent. solution is used for this purpose. It has the advantage of being less expensive and less dangerous than the solutions of corrosive sublimate.

Mercury and its salts are the most energetic antiseptics known, but they are at the same time the most toxic. We must distinguish, however, between the insoluble and the soluble salts; the bichloride (corro sive sublimate), which is soluble, is toxic in doses of 5 to 10 centigrammes, while the protochloride (calomel) is simply purgative in doses ten times greater—we should not forget, however, that in the presence of the chlorides of the gastric juice it may be transformed partially, and more or less rapidly, into the bichloride.

According to Miquel, the *biniodide* of mercury is the most powerful antiseptic known (equivalent, 25 centigrammes). The bichloride (corrosive sublimate) has only the fourth place (equivalent, 7 centigrammes).

Metallic mercury may be used, chiefly externally, in the form of *extinct mercury*, that is to say, mixed with a fatty body (lard, vaselin, or lanolin). The "resolutive" or antisyphilitic action formerly attributed to this topical agent must now be considered as an antiseptic action. A slight quantity of the

metal, which exists in a minutely divided state in mercurial pomade or *Neapolitan ointment*, is absorbed through the skin in inunctions. This ointment acts as an antiseptic in peritonitis, blennorrhagic orchitis, meningitis, lymphangitis, and local phlegmons. The absorption of the metal by the skin is proved by the characteristic salivation and by symptoms of poisoning which are sometimes very grave. Gubler and Merget think that in these circumstances the vapors of a metal which volatilizes at the ordinary temperature of the air may be absorbed by the digestive and pulmonary passages in considerable quantities, especially when the temperature of the human body reaches or exceeds 39 and 40 C., as is often the case with patients suffering from peritonitis or similar affections.

The *bichloride* ($HgCl_2$), or *corrosive sublimate*, is, of all the salts of mercury, the most commonly used as an antiseptic. At ordinary temperatures it requires fifteen parts of water or fourteen of glycerin to dissolve one of this salt, but in alcohol and ether it is much more readily soluble (1:4).

It will not do to use ordinary water to dissolve this salt, for the lime contained in the water would cause a more less abundant precipitation. If distilled water is not used, the tendency to precipitation may be counteracted by the addition of common salt.

Vicario and Deschamps have recommended, as

equivalent to the *Liquor Van Swieten*, the following solution:

Corrosive sublimate..................	1
Sodium chloride.....................	1
Ordinary water......................	1000

Van Swieten's solution (French Codex) consists of one gramme of corrosive sublimate dissolved in one litre of water. It is in great favor among the physicians of France, being employed externally as an antiseptic and for injections into the vagina, uterus, etc. It may be dangerous in some cases to employ this preparation in full strength. The Academy of Medicine, in accordance with the report of Dr. Budin, has authorized midwives to use a solution of corrosive sublimate somewhat weaker than the liquor of Van Swieten.

Mercurial antiseptic is sold by the pharmacists in the form of powder, in little packages made according to the following formula:

Bichloride of mercury...............	0.250
Tartaric acid.........................	1.000
Bordeaux red.........................	0.001

M.

Each package contains enough for one quart of water. The red color (Bordeaux red) is designed to attract attention and to prevent any mistake that might result in poisoning.

A sublimate vaselin, 1:4000, is used for lubricating the hands and instruments.

Laplace was the first to show (in 1887) that the addition of $\frac{5}{1000}$ of hydrochloric or tartaric acid to a solution of corrosive sublimate considerably augments its antiseptic power, by preventing the mercurial salt from forming an insoluble albuminate with the albuminoid matters of the tissues of the organism.

Corrosive sublimate, even in such minute quantities as 1:20000, destroys fully developed bacteria. Some bacteria are more susceptible to its action than others.

Protochloride of mercury, mercurous chloride, or calomel (Hg_2Cl_2), is insoluble in water, and this is why we are able to administer it in much larger doses than bichloride. In presence of hydrochloric acid and of alkaline chlorides, it splits up into mercury and bichloride, especially when organic matters are present. Its action, then, resembles that of the soluble mercuric compounds from the point of view of toxicity and antisepsis. The English physicians employ it frequently in diseases of children, for enteritis, meningitis, etc. It is also employed externally in the form of ointment.

The *black oxide* of mercury (mercurous oxide) is the basis of the "black wash," made by adding a drachm of calomel to a pint of lime-water.

The *mercuric oxide* or *binoxide*, in more general use, is red, and forms the basis of collyria and pomades for venereal ulcers and diseases of the eyes. It is the basis of the "yellow wash."

The *acid nitrate* of mercury (mercuric azotate), in solution with an excess of nitric acid, is employed as a caustic for syphilitic ulcers.

Mercurous iodide (Hg_2I_2) is green, insoluble in water; it is a favorite antisyphilitic remedy, and is given internally in doses of from ¼ to 1 grain.

Mercuric iodide (HgI_2) or the *biniodide* of mercury, is a much more active compound. It is a red powder, slightly soluble in water (one grain to the quart) and soluble in alcohol and ether. This is the most powerful of antiseptics thus far experimented with (equivalent, 25 milligrammes [Miguel]). According to Pinard, who has employed it in puerperal affections in place of corrosive sublimate, it gives better results than the latter. "The biniodide, eminently antiseptic, is less toxic in equal weights than the bichloride," says Bouchard. Pinard uses a solution of 1 to 4000, which corresponds as to toxicity to the solution of sublimate which the Academy thinks safe to put into the hands of midwives. As an antiseptic it is probably three times as active, in spite of its perfect innocuousness.

The *yellow subsulphate* of mercury, or turpeth mineral, is employed in ointment in parasitic affections of the skin. It is but little soluble in water, and insoluble in alcohol. Internally it acts as an emetic and purgative.

The *mercuric sulphide* (HgS), cinnabar or vermilion red, is insoluble in water and alcohol, and

volatilizes without melting. It is employed externally in pomades and fumigations.

The *black sulphide*, or Ethiop's mineral, which has the same formula as the preceding, is obtained by triturating sulphur with mercury; it is formed also by the action of hydrogen sulphide and of the alkaline sulphides on the mercuric salts. Its insolubility renders it little toxic.

This indicates the way to treat poisoning produced by the application of a mercurial ointment, especially when there is reason to suppose that the poisoning is due to absorption of mercurial vapors by the pulmonary passages. As an antidote, you will administer the sulphur mineral waters (Cauterets, Uriage, Enghien, etc.) which transform the soluble salts of mercury into insoluble sulphides. When these sulphur waters are administered in advance, there is a remarkable tolerance towards mercurial inunctions.

Other antiseptic mercurial preparations which belong to organic chemistry will be mentioned further on.

IRON; CHROMIUM; MANGANESE; NICKEL; COBALT.

The salts furnished by the metals of this group are in general only moderately antiseptic, and hence are rarely employed in this capacity. As an exception to this rule, chromic acid is very strongly antiseptic.

Iron and the *salts of iron* are not toxic, even in relatively large doses. Being found in the organism as well as in our foods, they are very feebly antiseptic; thus the *sulphate of protoxide* of iron has for its equivalent the high figure of 11 grammes per litre (Miquel).

In the *protochloride* and *protiodide* of iron the chlorine and iodine act probably as antiseptics, while the iron is a reconstituent of the blood. However this may be, we may say that the salts of iron are not in use as antiseptics. For external use, and for all local applications, the salts of copper are preferable, being much more active.

The salts of *Manganese* are essentially the succedanea of iron. I have already spoken of permanganate of potash, the most used of these salts and the most strongly antiseptic.

Chromic acid (CrO_3) crystallizes in beautiful red needles. It is deliquescent, of a styptic taste. It is an energetic oxidizer, for it inflames alcohol and ether by simple contact. Applied to the tissues, it is very caustic, and as such it is employed with an equal weight of distilled water to destroy corns and cauterize vegetations. Its antiseptic equivalent is almost as high as that of osmic acid, and superior to that of chlorine, being 2 decigrammes (Miquel).

Bichromate of potash is also an energetic oxidizer, as I have already said; it is strongly antiseptic.

Chromic acid and the salts of chromium are not in use as antiseptics.

The salts of *Cobalt* and of *Nickel* have properties similar to those of the preceding. The *sulphate of nickel* is strongly antiseptic, superior in this respect to permanganate of potash and especially to the sulphate of iron. Its antiseptic equivalent is a little inferior to that of chloride of zinc.

ALUMINIUM.

This metal resembles the preceding, although it is not diatomic but hexatomic, its salts having this grouping: $(Al_2)_6$. Very few of its salts are employed as antiseptics. Alum, a feeble base, is astringent.

The *double sulphate of alumina and potash*, $(SO_4)3Al_2SO_4K_2+24H_2O)$, when introduced into the digestive tube is toxic in the dose of 15 grains or even less. It is astringent, and is employed chiefly in gargles. Coagulating albumen, it prevents the putrefaction of organic matters.

Burnt alum, employed chiefly in powder, acts as an absorbent of water from the tissues on which it is deposited, and it is probably in this way only that it acts on bacteria, so sensitive to the least change in the degree of concentration of the liquids in the midst of which they live. It is not considered as a true antiseptic.

The *acetate* of alumina is, on the contrary, considered as a powerful antiseptic. I shall speak of it again with the other organic compounds derived from acetic acid.

GOLD; PLATINUM; OSMIUM.

The salts of gold were formerly employed in scrofula and in syphilis. Recent researches, in showing the elevated antiseptic rank of gold and its compounds, tend to restore this metal to its former therapeutic importance. The sole obstacle to the employment of the salts of gold is their high price.

Gold in powder, the chloride and bromide of gold, alone or in combination with ammonium or sodium, the cyanide and the oxide of gold, have been employed internally and externally in doses indicated in the Codex. Chloride of gold is a caustic which has the reputation of not leaving cicatrices; it is soluble in water, alcohol, and ether. It is strongly antiseptic. In Miquel's list it follows iodine and chlorine, with an equivalent of 25 centigrammes, equal to that of these two metalloids.

Cyanide of gold, formerly prescribed by Chretien, has again been employed by Œsterlen in phthisis; this salt is yellow, insoluble. It is given in the dose of 4 to 16 milligrammes ($\frac{1}{15}$ to $\frac{4}{15}$ grain).

The *tricyanide of gold*, colorless and soluble, has also been employed by the same authority.

The salts of *Platinum* resemble the salts of gold by their properties, but they are less active, while being very costly. *Bichloride* of platinum has for antiseptic equivalent 30 centigrammes, a figure higher than that of hydrocyanic acid.

Osmium is used only in the form of *osmic acid*

(OsO_4), a volatile body at ordinary temperatures (giving off the vapors of osmium), which gives it a resemblance to mercury; it dissolves slowly in water. It is an energetic oxidizer, very easily decomposing, with metallic reduction, in contact with organic matters. It is irritant by contact of its vapors, and caustic in large dose. It is an energetic antiseptic, superior to the preceding, and taking rank, according to Miquel, immediately after nitrate of silver (antiseptic equivalent, 15 centigrammes).

Much employed in micrography and in bacteriology to define the tissues and lower organisms, osmic acid, by reason of its high price, is not used in therapeutics. It has been employed in hypodermatic injections as an antineuralgic (in 1-per-cent. solution).

M. Maggi employs osmic acid in the analysis of potable waters, as it kills instantly all the microbes and precipitates them to the bottom of the vessel, where it is easy to collect them.

CHAPTER II.

ANTISEPTICS BORROWED FROM ORGANIC CHEMISTRY.

GENERALITIES AND CLASSIFICATION.—The antiseptics borrowed from organic chemistry are to-day much more numerous and varied than those of the inorganic field; it is, then, necessary to make of them a serious study—a study which is rendered peculiarly difficult by their very complex constitution and the often fanciful names applied to many of them—names which have no relation to the chemical formula under which they are known.

By organic chemistry was formerly understood the description and properties of bodies extracted from the organs of plants and of animals. To-day, now that bodies of the same nature have been obtained artificially by the aid of minerals, we say that organic chemistry is *The science of all the carbon compounds* (Grimaux).

In these compounds, carbon is associated with the three simple bodies, hydrogen, oxygen, and nitrogen, and these four elements, of themselves alone, by the difference in their respective proportions, furnish already many thousands of organic compounds. But they are capable besides of uniting with sulphur, phosphorus, almost all the metalloids, and several

metals, thus augmenting still more the number of the organic compounds with which we are here concerned.

The recent researches of Rottenstein and Bourcart* have shown that the antiseptic power of the organic substances depends on the *grouping of the atoms* of C, H, O, N, etc., which constitute their chemical molecule, but especially *on the number of these atoms.*

The antiseptic power of an organic compound is directly proportional to the number of hydrocarbon groups (naphtyl, phenyl, methyl) or of halogens (chlorine, bromine, iodine) which are found linked together in the elementary molecule of the chemical compound.†

The greater the number of times a combination contains the hydrocarburets CH_3, C_6H_5, $C_{10}H_7$, and their derivatives, the greater is its bactericidal power. The group naphtyl ($C_{10}H_7$) is about twice as antiseptic as the group phenyl (C_6H_5), and the latter is five or six times more energetic than the group methyl (CH_3).

Oxygen combined with C and H, and even with N, *much augments* the bactericidal powers of the derivatives of these hydrocarbons.

Nitrogen, on the contrary, combined with one or

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* Rottenstein and Bourcart, "Les Antiseptiques," etc. Paris, 1891.

† Rottenstein and Bourcart, *loc. cit.*

two atoms of hydrogen *always lowers the antiseptic power* of an organic combination.

I must make exception to the cyanogen group (CN), which behaves as a halogen element and appears to be at least as active as chlorine; as well as to the ammonium group (NH_3), which behaves as a metal. Both are violent poisons, and their organic compounds present similar properties.

The substitution, in an amide group (NH_2), of an antiseptic group (naphtyl, phenyl, etc.) for one or two hydrogens, immediately raises the bactericidal nature of the compound.

Lastly, when we study the action of antiseptics on the microbes, we must distinguish two things: (1) the effect of the composition of the substance *directly* on the bacteria; (2) the effect of the products of the decomposition of these substances by the bacteria on the bacteria themselves. The first case is applicable to all substances containing halogens (Rottenstein and Bourcart).

These general considerations shed a vivid light on the study of the organic antiseptics, and to such a degree that (in the words of the writers cited above) "in the future it will be possible, as soon as we know the chemical constitution of a substance, to establish not only the antiseptic power, but also to compare this power with that of other substances already classed."

From the point of view of the toxic equivalent of

antiseptics, there is a final general observation to make. Bouchard has remarked that in inorganic chemistry the mixture of several antiseptics gives a product more antiseptic, *without being more toxic*, than each one of the antiseptics taken separately. This law finds its application in organic chemistry, with this difference, that the organic antiseptics are *well defined chemical compounds* and not simple mixtures. Thus it is that iodoform is much less toxic than pure iodine administered in the dose in which it enters into the composition of the organic molecule, CH_3I, which acts, besides, by its methyl radical.* This it is that legitimizes the preference which is given to-day in antisepsis to the complex bodies of organic chemistry over the simple bodies of mineral chemistry.

We shall study the antiseptics of organic origin in the following order:

1. Saturated hydrocarbons, fatty series or derivatives of methane, alcohols, ethers, and organic acids.
2. Aromatic series, or derivatives of benzine.
3. Alkaloids.

Most of these latter, though having numerous applications in medicine, do not, strictly speaking, belong to antiseptic therapeutics.

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* According to the formula of Dujardin-Beaumetz and Yvon, iodoform may be given internally in the dose of 10 to 20 centigrammes, while pure iodine is toxic in a larger dose than 1 to 5 centigrammes. Iodoform contains 90 per cent. of iodine.

§ 1. SATURATED HYDROCARBONS, FATTY SERIES OR DERIVATIVES OF METHANE.

The saturated hydrocarbons, of which marsh gas (CH_4) is the best known type, constitute a numerous series of bodies represented by the general formula: C_nH_{2n+2}. These bodies differ from each other only by the number of units of the radical CH_2, and present a great similarity of properties. Treated by chlorine, they furnish products of substitution (hydrochloric ethers); then, under the influence of appropriate reagents, homologous alcohols, etc. We must refer the reader to treatises on chemistry for the detail of these divers reactions, which furnish a great number of organic compounds, gaseous, liquid, or solid, at the ordinary temperature, and of which several are considered as antiseptics. Such are *paraffin*, *petroleum*, *vaselin*, *alcohol*, *chloroform*, etc.

PETROLEUM.

Crude petroleum, which is so well known, is a natural mixture of saturated hydrocarbons which may be purified by successive distillations. It is toxic.

According to the researches of Dubief, crude petroleum prevents the development of aërobic microbes, notably those of suppuration, but does not act on the spores of *Bacillus anthracis*. Its antiseptic power is but moderate.

Petroleum has been recently recommended as useful for swabbing the throat and for gargles in

diphtheritic angina. Its use is well tolerated, notwithstanding the bad taste of the liquid, and the results obtained (forty-two cases, forty recoveries) are very encouraging.* Petroleum softens and detaches quite rapidly the false membranes.

VASELIN.

Vaselin, or petrolin, is a mixture of paraffin and the heavy oils of petroleum. By reason of its chemical composition, it does not become rancid like the fats, and ought to replace these in all ointments designed for antiseptic uses.

ALCOHOLS: METHYLIC, ETHYLIC, ETC.

Methyl alcohol (CH_4O) is the product of the dry distillation of wood, just as ethyl alcohol (C_2H_6O) or the spirit of wine is the product of the distillation of wine (juice of the grape and other sweet juices, as beets, sugar-cane, etc.).

Dujardin-Beaumetz was the first to show that the toxic equivalent and the antiseptic equivalent of the alcohols increase simultaneously and proportionally to their atomic formula,† as the following table indicates:

	Degree of Asepsis.
Ethylic alcohol, C^2H^6O	95
Propylic alcohol, C^3H^8O	60
Butylic alcohol, $C^4H^{10}O$	35
Amylic alcohol, $C^5H^{12}O$	14

* Larcher.

† Dujardin-Beaumetz and Audigé, "Experimental Researches on the Toxic Power of the Alcohols." Paris, 1879.

It is very difficult to obtain these alcohols in a state of absolute purity in commerce. This explains the differences which are remarked between these figures and those given by Bouchard. According to the latter authority* methyl alcohol (CH_4O) is the least toxic and probably the least strongly antiseptic of all the alcohols. This is what its chemical formula indicates. At the same time we should remember that man is habituated to the ethyl alcohol, which predominates in wine, and antiseptic effects are modified by accustomance.

Alcohol being very often employed as an excipient or to promote the solubility in water of antiseptic substances which are not soluble in the latter liquid, we easily understand the importance of these figures.

But alcohol is also employed in therapeutics in order to obtain the special action which it exercises on the organism, independently of the other substances which may be associated with it. The query is then pertinent in this place: Does alcohol possess in itself an antiseptic action ?

It is especially by the oxygen which they contain that the alcohols ought to be considered as bactericidal, so that the greater the amount of oxygen there is in combination with hydrogen, the more antiseptic the alcohol will be. Thus, the alcohols with several

* Bouchard, "Therapeutique des Maladies Infectieuses," p. 222.

hydroxyles (OH) will be more antiseptic than those that contain but one. The hexatomic alcohols which contain six groups OH, such as mannite ($C_4H_{16}O_6$), would then theoretically be more strongly antiseptic than the monoatomic alcohols, like ordinary alcohol. We have not yet made experiments in this direction, the derivatives of methane (CH_3) being moreover considered as feeble antiseptics; in other words, the group CH_3 does not give of itself any great antiseptic value to a compound, and the presence of oxygen does not materially raise this value when we come to the matter of utilizing these compounds in the practice of antisepsis.

However this may be, the antiseptic action of ethyl alcohol has often been utilized in medicine, as in the dressing of wounds, etc., to oppose putrefaction and fermentation. Gubler says its properties are due essentially to its greed for water and its power of coagulating albumens. Internally it acts as a diffusible stimulant, a respiratory aliment, and producer of force (*dynamophore*). Its action is probably more complex still.

Many facts tend to prove that alcohol acts chiefly on the non-figured ferments which resemble diastases. Alcoholic solutions of 10 to 33 per cent. retard or arrest the action of these ferments; and if it be remembered that the toxines secreted by the microbes have often the chemical nature of diastases, it may be asked if alcohol does not act in infections, in part at least, by neutralizing these toxines?

We know that the most efficacious internal treatment yet known for general poisoning produced by the venom of serpents communicated by a bite, consists in giving alcohol in large doses. The patient is literally made drunk, and he is kept in a state of intoxication till the general symptoms are improved. So also in pneumonia, the alcohol which is administered in the form of whiskey or brandy may be regarded as exerting an influence (however little or great) on the toxines secreted by the microbes which pullulate in the diseased lung.

The action of alcohol on the microbes themselves, however feeble this may be, should also be taken into account. According to Jalan de la Croix, a 5:100 solution of alcohol prevents the development of bacteria in a culture-bouillon, while it needs 22:100 to destroy them when they are in full development, and 83:100 to sterilize the germs of the latter. A solution of 5 per cent. prevents the development of bacteria in a mixture of raw meat and cold water. Before the dressing of wounds by phenic acid was popularized by Lister in 1873, surgeons daily employed alcohol diluted with water, or containing other substances in solution as antiseptic as itself, such as camphor, arnica, etc., for their dressings. At the present time, alcohol more or less diluted enters as a solvent in the phenicated solutions which have replaced the preceding, and in a great number of other antiseptic solutions of which I shall speak farther on.

GLYCERIN: $C_3H_5(OH)_3$.

Glycerin is a triatomic alcohol, very much employed to-day in therapeutics, pure or associated with other medicaments to which it serves as an excipient. It is soluble in water and in alcohol. Its solvent properties are intermediate between those of alcohol and those of water. It dissolves a great number of metallic salts and other substances.

Glycerin preserves organic matters in the same manner as alcohol, but its bactericide equivalent is much more feeble. It prevents the development of most bacteria, but favors that of the tubercle bacillus (Bouchard). It acts probably largely by its avidity for water, which it takes from the organic cells with which it is put in contact. It is a very feeble antiseptic (equivalent, 225 grammes, according to Miquel).

Bouchard has shown that glycerin is a bad excipient for hypodermatic injections. It produces albuminuria and hæmoglobinuria. On the contrary, it is better to use glycerin than alcohol for phenic solutions, for alcohol diminishes the antiseptic power of phenol.

CHLOROFORM: $CHCl_3$.

Chloroform, or methyl chloride, trichloride of methane, should be considered as a hydrocarbon of the formula of methane (CH_4), or marsh gas, of which an atom of H is replaced in the chemical molecule by three atoms of chlorine.

Chloroform is a very mobile liquid, more dense than water, in which it is little soluble (1 part to 100); soluble in every proportion in alcohol and ether; insoluble in glycerin. Applied pure to the skin and mucous membranes, it rapidly produces vesication; even when diluted with water it produces a marked rubefaction.

It is a good antiseptic, the action of the chlorine being added to that of the hydrocarbon. Miquel classes it as strongly antiseptic (equivalent, 80 centigrammes). In the dose of 1 per 100 it paralyzes bacteria and prevents their development; to sterilize germs, equal parts of chloroform and water are required.

Chloroform water, obtained by agitating chloroform and water and decanting, is a 1-per-cent. solution, and is employed in full strength or diluted as an antiseptic and analgesic of the digestive tube.*

CHLORIDE OF ETHYL BICHLORIDE: $C_2H_3Cl_3$.

Ethane-trichloride, or chloride of ethyl bichloride, according to its composition (an extra CH_3) is a more energetic antiseptic than chloroform. It is not used in medicine.

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* Note that chloroform is the first term of the series of halogen compounds of methane which we are to study successively in passing to compounds that are of progressively increasing energy due to the adjunction of a greater number of atoms of hydrocarbons and of halogen radicals.

The *sesqui-chloride of carbon* (C_2Cl_6), a perchloride derivative of the preceding, has been employed with success in cholera in the dose of 25 centigrammes every half-hour during the algid period. It is a crystallizable body with the odor of camphor.

CHLORAL: C_2HCl_3O.

Chloral, or aldehyde-trichloride, is liquid, but is only employed in medicine in the form of chloral hydrate (C_2HCl_3O, H_2O), which is in white, hard, crystals, melting at 48° C., and subliming at the ordinary temperature, giving off a penetrating odor.

Chloral, containing in its molecule only two atoms of chlorine, is an antiseptic less energetic than chloroform, which has three, but it also acts by its atom of oxygen. According to Miquel, it is moderately antiseptic, with the equivalent 9.30 grammes.

According to Dujardin-Beaumetz and Hirn, one part of chloral suffices to arrest the fermentation of one hundred parts of putrescible matter. This corresponds well to the antiseptic equivalent given by Miquel.

Its solubility in water renders it of advantage for the dressing of gangrenous and fetid wounds (solution of 1 per 100), and for injection in empyema after the evacuation of pus.

TRI-CHLORACETIC ACID: $C_2HCl_3O_2$.

This body, though a good antiseptic, is not in use. It acts by the chlorine and the acetic acid

which it contains. It is solid, in colorless crystals, of agreeable odor, a little pungent; soluble in water and alcohol; very caustic; in concentrated solution it coagulates albumen. In solution of 1 or 2 per 100 it destroys all the micro-organisms; in weaker solutions it prevents the development of bacteria, but not the action of the non-figured ferments. Its antiseptic power would place it immediately after corrosive sublimate and phenic acid.

IODOFORM: CHI_3.

Iodide of methyl biniodide, or iodoform, is in yellow crystals, which are insoluble in water. Its strong, penetrating and persistent odor is the only disadvantage that this antiseptic presents, which for several years has almost entirely replaced carbolic acid in surgical practice. It is soluble in boiling alcohol (12 per 100), ether (6 per 100), chloroform, benzene, the fixed and volatile oils; insoluble in glycerin.

It is strongly antiseptic, with an equivalent of 60 centigrammes (Miquel). It is believed to act by becoming decomposed in contact with the tissues, first into iodates and iodides of sodium and potassium, then by the setting free of iodine in the nascent state (it contains 90 per cent. of iodine by weight). It is an energetic stimulant to cicatrization. It would be very interesting to know what is its action on the leucocytes, embryonic cells, or migratory cells which

constitute pus.* It certainly seems to limit the suppuration of bleeding surfaces. It is employed in the form of powder, iodoform gauze, iodoform collodion, etc. The dose for internal administration would be one to two grains three times a day, in pill form, but it is comparatively little employed internally. Dissolved in the oil of sweet almonds, it may be used as a collutorium in septic angina.

Many ways have been devised to mask the odor of iodoform. Thus, some associate one part of ground coffee with two of iodoform. Phenic acid, camphor, essence of peppermint, have all been recommended; menthol, creolin, vanillin, in some measure remove the offensive odor. Perhaps nothing better fulfills the object sought than camphor—one part to five or ten of iodoform. Cases of poisoning by iodoform when used externally have been reported, and it is well to be careful not to sprinkle it very lavishly over large ulcerated surfaces.

IODOL: C_4I_4NH.

Iodol, which as an *amine* or *ammoniacal compound*, is a good antiseptic. It is a crystalline powder, yellowish-brown; tasteless; very slightly soluble in water (1 to 5000); soluble in alcohol, ether, the oils, and

*It promotes the phagocytic activity of leucocytes; it represses the activity and development of pus-microbes. (See the recent experiments of Maurel as recorded in Boston Medical and Surgical Journal, Oct. 19, 1893).—TRANSLATOR.

alcohol and glycerin. It has been used for the same purposes and in the same manner as iodoform (powder, glycerin containing the powder in suspension, iodol-vaselin, iodol-gauze, etc.), and the results have been very satisfactory, except in gangrenous ulcers. A. Trousseau has used it to advantage in ocular therapeutics.

This preparation contains 88 per cent. of iodine — almost as much as iodoform. Its advantages over iodoform are its absence of odor, its less irritant action, and its perfect innocuousness. It would seem to be much safer than iodoform; it is, however, more expensive.

IODOPHENINE.

This compound, which resembles the preceding, is soluble in acetic acid (1 to 20) and in alcohol, but almost insoluble in water. It contains 50 to 60 per cent. of iodine. In solution of 1 to 5000 it kills the microbes of pus (*staphylococcus aureus*) after a contact of five minutes (Scholvien).

BROMOFORM: $CHBr_3$.

Bromoform, the analogue of chloroform and iodoform, is a colorless liquid, very dense, of quite agreeable odor, more powerful as an anæsthetic than chloroform. It has been vaunted as specific in whooping-cough.

It is a powerful antiseptic, and has been used with success in the treatment of diphtheria. Its

action is both antiseptic and anæsthetic. But bromol is generally preferred.

BROMOL: $C_6H_3OBr_3$.

Bromol, or tribromophenol, belongs to the aromatic series, but I shall speak of it here on account of the relations it bears to bromoform. Its composition indicates that it is a much more energetic antiseptic.

It is a powder of lemon-yellow color, of sweet and astringent savor, with characteristic but not disagreeable odor; insoluble in water; soluble in glycerin, alcohol, ether, chloroform, and the essential oils.

Although little toxic, this body possesses marked antiseptic properties: a piece of meat dusted over with bromol keeps without spoiling for several days at the temperature of 30° C. (86° F.).

It is employed externally as a dressing for ulcers and wounds, in powder or mixed with vaselin. In infectious anginas it has the advantage of being soluble in glycerin. It has also been employed in typhoid fever, cholera infantum, abscess of the lung (Rademaker).

In short, bromol is the best antiseptic we have yet studied, and it might with good reason be substituted for iodoform, having neither the disagreeable odor nor the toxic action of the latter. In iodol the radical NH lowers the antiseptic power, while in the molecule of bromol *all is utilized for antisepsis.*

ORGANIC ACIDS.

The organic acids, like the preceding compounds, are antiseptics which are the more powerful the greater the number which their molecule contains of groups of COOH, OH, CO, COH, and CH_3, C_2H_5, so that we may range them in the following order:

Formic acid, CH_2O_2.
Acetic acid, $C_2H_4O_2$.
Lactic acid, $C_3H_6O_3$.
Tartaric acid, $C_4H_6O_6$.
Citric acid, $C_6H_8O_7$.

The first acid of this series being the least antiseptic, and the last the most antiseptic, this law, which is the corollary of that which we have announced for all the compounds of methane, is similar to the law governing the antiseptic power of the alcohols, and sufficiently explains the action long since known of citric acid on the pathogenic microbes.

Formic acid, according to Schulz, in 1-per-cent. solution prevents the putrefaction of pancreas, and in 0.25-per-cent. that of fibrin. Schulz has, by means of this acid, kept a culture liquid free from the development of germs for six months.

Acetic acid has been used by Roth and Angelmann as antiseptic and disinfectant. According to the latter, a 3-per-cent. solution is a good antiseptic to employ in gynæcology, as being much less toxic than phenic acid. For external use we may increase the strength of the solution to 20 per cent. Acetic

acid is the basis of numerous aromatic vinegars employed as lotions. On the whole, it is a feeble antiseptic.

Several *metallic acetates* are employed in medicine; their action is due both to the acid and to the metal of their composition (acetate of lead, acetate of copper, etc.).

Lactic acid has been prescribed by Hayem and Lesage as antiseptic in the "green diarrhœa" of infants. Their formula is two parts of lactic acid to one hundred of the vehicle (syrup or mucilage), in teaspoonful doses.

It has also been employed as a topical agent in diphtheria, in tuberculous ulcerations of the larynx, and in epitheliomata.

Oxalic, *tartaric*, and *citric* acids are placed in almost the same rank by Miquel, among the *strong* antiseptics; they are, however, less active than the mineral acids, and the latter less so than the acids of the aromatic series (salicylic and benzoic). Their equivalent varies from three to five grammes per litre of culture bouillon.

Oxalic acid has been prescribed externally and internally in diphtheria. A good solution for swabbing the throat is one part of acid to twenty of water or one hundred of glycerin.

Tartaric acid is not used as an antiseptic. The bitartrate (cream of tartar) is employed as a purgative in the dose of one-half ounce to one ounce. The

double tartrate of potassium and sodium (Rochelle salt) is given in the same dose, or in somewhat larger doses. The tartrate of antimony and potash, or tartar emetic, is employed as an emetic and purgative in the dose of one-half to three grains, and in smaller doses as a sudorific, sedative, and expectorant. It is a very active and very untrustworthy medicament, whose local action on the digestive tube and general action on the organism should be watched.

Citric acid is, as its formula indicates, the most efficacious antiseptic of the series. It presents itself under the form of white crystals, soluble in three-fourths their weight of cold water, in alcohol, and in ether. It is extracted from the juice of lemon. It also exists in currants, strawberries, raspberries, cherries, and oranges.

The antiseptic equivalent of citric acid is 3 grammes to a litre of culture bouillon; *i. e.*, about the same as that of the mineral acids, hydrochloric and acetic, with the difference that citric acid is much better supported by the organism. Thus, one may give two to six grammes per day internally, while it is not safe to exceed one or two grammes of hydrochloric acid diluted in at least a quart of water. However, citric acid is only employed as a topical agent.

Under the form of lemon-juice, citric acid was formerly used to touch ulcers affected with hospital gangrene. It is chiefly employed to-day as a gargle in pseudo-membranous anginas.

CYANOGEN AND CYANIDES.

To the group of ammoniacal compounds (amides and nitriles) are related the compounds of the group CN (cyanogen), which behaves in its combinations like a simple body, a metalloid of the same group as chlorine, iodine, and bromine.

Hydrocyanic acid (CNH) is the *nitrile of formic acid.*

All bodies which contain the radical CN or Cy are energetic antiseptics, but at the same time extremely violent poisons, more toxic than mercury and its salts; and this singularly restricts their employment in therapeutics. Were it not for this toxicity, we might employ the cyanides as we employ the chlorides, iodides, and bromides. According to Miquel, the cyanide of potassium is strongly antiseptic (equivalent, 1.20 grammes). The cyanide of mercury is still more energetic, and hydrocyanic acid has for an equivalent 0.40, a figure however inferior to that of iodine (0.25) and only about one-sixth that of corrosive sublimate (0.07).

Cyanide of mercury ($HgCy_2$) has been employed as an antiseptic internally. Erichsen, Annuschat, Rothe and Schultz have prescribed it in diphtheria in very minute doses (1 to 10 centigrammes in 120 grammes of peppermint-water; dose, a teaspoonful every hour). The ferrocyanides have not been employed as antiseptics.

SULPHIDE OF CARBON AND ORGANIC SULPHUR COMPOUNDS.

The bisulphide of carbon (CS_2) is a heavy liquid, very slightly soluble in water. At the same time, on agitating it with water, and leaving the water in contact with the sulphide in excess, we obtain *bisulphide of carbon water*, prized by Dujardin-Beaumetz as an antiseptic in putrid dyspepsia.

Sulphocarbol, sulphaminol, sulphobenzoate of soda, sozoiodol, etc., belong to the aromatic series, of which we are now to speak.

§ 2.—HYDROCARBONS OF THE AROMATIC SERIES, OR DERIVATIVES OF BENZENE.

Benzene (C_6H_6), or *benzol*, is the first term and the base or nucleus of a numerous series of compounds very important for us, for they are all more or less antiseptic, and some of them are probably the best antiseptics which organic chemistry furnishes. As these bodies have all a strong and aromatic odor, and many even are essences, the name *aromatic* has been given to this series.

To show the importance of the aromatic series in therapeutics, it suffices to say that the phenols, the naphthols, salicylic acid, and all their derivatives, so much employed the last few years, belong to this

group of organic compounds. To facilitate the study of this numerous series, we shall pass successively in review, in the order which we indicate below:

1. The aromatic hydrocarbons (methyl group).
2. The oxygenated hydrocarbons (group phenyl) and the aromatic acids associated with them.
3. The hydrocarbons of the group naphtyl.
4. The hydrocarbons of the group of ketones and quinones.
5. The hydrocarbons containing hydrogen.

With each of these different groups we shall study the haloid and sulphur compounds which belong to them.

AROMATIC HYDROCARBONS (GROUP METHYL: CH_3), BENZOL, TOLUOL, ETC.

The hydrocarbons of this group are feebly antiseptic, their bactericidal power increasing in proportion as the hydrogen is replaced in the benzol (C_6H) by CH_3 or other antiseptic groups. In studying successively benzol, toluol, xylol, mesithylene, hexamethyl-benzol, we pass progressively to compounds more and more energetic.

Benzol (C_6H_6), or benzene, which everybody knows, is a colorless liquid of quite agreeable odor when it is pure, almost insoluble in water, very soluble in alcohol and ether. It dissolves iodine, sulphur, phosphorus, camphor, and most of the organic substances rich in carbon. It is not used in medi-

cine. Toluol and the other compounds enumerated above are also not used as antiseptics. Their properties resemble those of benzol. All are very volatile and inflammable.

ANILIN AND FUCHSIN.

Among the derivatives of benzene and nitrobenzene (essence of mirbane), anilin is one of the most important in the arts. From it is derived fuchsin, or anilin red, a product now for several years utilized in therapeutics.

Fuchsin is obtained by treating anilin with oxidizing agents (nitrate of mercury, arsenious acid). This body is a chloride of rosanilin, as its formula shows: $C_{20}H_{13}N_3HCl$. It presents itself under the form of crystals of a greenish-red color, the solutions of which are a beautiful violet-red, which fixes itself readily on all organic substances and colors them solidly without any need of a mordant.

Fuchsin is employed externally and internally as an antiseptic.

It has been used internally in the treatment of Bright's disease (Feltz and Ritter). It is given in capsules in the dose of 2 grains (0.12) twice a day. This medicament colors the urine red, and is always well supported.

Fuchsin is employed externally in the treatment of chronic and rebellious ulcers. It acts both as an

antiseptic and as an analgesic. It is applied in solution as follows:

Fuchsin	....	0.70
Alcohol } Water }	ää	215.

M. For external use only.

After painting, cover the sore with a piece of gauze soaked in the same solution, and over this place a little isinglass plaster, absorbent cotton, and a bandage. This medicine has no inconvenience but its color, which long stains the skin red.

OXYGENATED HYDROCARBONS, PHENOLS AND OXY-BENZOLS (PHENYL GROUP: C_6H_5).

These compounds, like the aromatic acids, are, as we have said, five or six times more antiseptic than the benzols and analogous compounds. They have, besides, the advantage of being for the most part soluble in water.

Tannin, phenol, creasote, guaiacol, salol, and thymol belong to this group, and possess bactericidal properties which are of increasing efficacy in the order in which we have named them.

TANNIN.

Tannin, or tannic acid ($C_{14}H_{10}O_9$), is an amorphous powder, of a grayish-yellow color, behaving as an organic acid. Employed formerly as an astringent (of which class of vegetal medicaments it is the

type), it is now also used for its antiseptic properties, brought to light by Raymond and Arthaud in the treatment of tuberculosis. (These practitioners give doses of one to five grammes per day.) As an antiseptic it is superior to pyrogallic acid (equivalent, 4.80 grammes, according to Miquel). Tannin has been employed externally in blennorrhagia, leucorrhœa, and furunculosis.

Tannate of bismuth is employed as an anti-diarrhœic medicine; *tannate of lead*, in powder, for eschars of the sacrum; *tannate of zinc* for inveterate blennorrhagic discharges.

Rhatany, *kino*, *catechu*, and multitudes of other vegetable productions owe their astringency to tannin, which they contain in variable proportions.

PHENOL, PHENIC ACID, CARBOLIC ACID: C_6H_6O.

Phenol, or phenic acid, is not a true acid. By its properties it resembles the alcohols, but it has actions which are peculiar to it alone. There exist a great number of phenols, which all possess the property of combining with chlorine, bromine, iodine, and sulphur, the most of which are good antiseptics.

We obtain phenol from coal-tar, in which it exists ready-formed. It is solid, crystallized, melting at 34° C. Its odor is disagreeable; its savor is caustic; it attacks the epidermis, causing white superficial eschars, accompanied by burning and itching. It dissolves in twenty times its weight of water, and is

more soluble in alcohol and glycerin, the oils and ether. It is employed in pharmacy under three forms: (1) Crystallized phenic acid; (2) Absolute purified phenol, soluble in fifteen parts of cold water; (3) Liquid phenic acid, a mixture of 90 per cent. of phenic acid and 10 per cent. of alcohol, soluble in 18 per cent. of cold water; (4) Impure, colored phenic acid, which should only be employed as a disinfectant of contaminated places. For antiseptic purposes, only the absolute phenol should be employed, which is phenol in its purity.

It is given internally in the dose of 7½ to 15 grains (0.50 to 1 gramme), well diluted. The phenic water is a 1:1000 solution, and is convenient for internal use—dose, a tablespoonful. For surgical purposes the 5:100 solution of the U. S. P. is preferable:

Glycerite of carbolic acid............. ℥ x.
Distilled water..........q. s. to make Oj.

M. Each drachm contains one grain carbolic acid. Dose, one to two drachms.

Carbolic poisoning manifests itself by headache, vomiting, convulsions, black discoloration of the urine, and death may supervene in the midst of collapse.

The solutions in glycerin and oil and the pomades irritate the skin much less than the alcoholic or watery solutions, and simple cerate is a better excipient than vaselin.

According to Miquel, phenol, although strongly

antiseptic (equivalent, 3.20 grammes), is less so than the mineral acids, and a little more so than permanganate of potassium. Thymic, picric, benzoic, and salicylic acids are preferable in this respect. The popularity which this antiseptic enjoyed during the first twenty years of its use has considerably declined of late. Its internal use has been almost abandoned since we have known of naphthol, and for external use we now prefer salol and iodoform.

M. Gaucher has recommended as a topical application in diphtheria a mixture of camphor and phenic acid (5 to 10 parts of acid, 20 to 30 parts of camphor, 10 parts of alcohol, and 10 of olive oil). This liquid is caustic; hence the weaker solutions should generally be preferred. The *camphorated naphthol* is, in fact, a better antiseptic for swabbings and paintings in diphtheria.

CREASOTE; CRESYLOL; CRESALOL.

Creasote is an inconstant mixture of creosol, guaiacol, cresylol, and other aromatic principles of tar. It might be well, therefore, in therapeutics, to substitute guaiacol, which is superior to it as an antiseptic and is a well defined product, though more toxic.

Beechwood creasote is an oily, yellow liquid, of a strong and not very agreeable odor, pungent and caustic taste; little soluble in glycerin, much more so in the oils and alcohol. In 1:100 solution it sterilizes

germs. It is employed internally in tuberculosis and chronic bronchitis, of which it diminishes or dries up the muco-purulent secretions remarkably. It has been used in surgery to dress ill-conditioned wounds.

Creasote-water is employed like tar-water, and for the same purposes; creasote is one of the active constituents of tar. Internally, creasote is often given in drop doses as an anti-emetic.

Cresylol, *cresol*, or *cresylic acid* (C_7H_8O), is one of the active principles of creasote, of creolin, and of lysol. It is a monoxybenzol, and consequently a homologue of phenic acid, to which it is superior as an antiseptic. It is a liquid, with a strong odor of creasote; is insoluble in water, soluble in alcohol and glycerin. Of its salts, *cresylate of soda* is alone used.

Although more active than phenol, cresylol is less toxic, and may be substituted in the same dose for the former.

Lysol and *creolin* are impure products which can only be used as disinfectants. Creolin, little soluble in water, is employed in emulsion; lysol is soluble in almost any proportion.

Cresalol, or *salicylate of cresol* ($C_{14}H_{12}O_3$), is much more antiseptic than cresylol, owing to the presence in it of salicylic acid. Three isomeric compounds are known, which are all in the form of white powder, light, crystalline, insoluble in water, ether, and the oils.

Metacresol is preferable to iodoform for the

dressing of wounds; it gives as good results, and is less toxic, is a better diminisher of the secretions, and has no disagreeable odor.

Cresolated gauze is used in the same way as iodoform gauze.

RESORCIN AND OTHER DIOXYBENZOLS.

The phenols of this group are more active than the preceding. The principal are pyrocatechin, resorcin, and hydroquinone. Resorcin alone is used in medicine.

Resorcin ($C_6H_6O_2$) is crystallized; very soluble in water, alcohol, and ether. Its great solubility in water, and its little causticity, render it very valuable for external use. Its odor is almost *nil*, and its taste is sweet. Given internally, it is not toxic, although its antiseptic power is greater than that of phenic acid (Callias). A 5-per-cent. watery solution is employed for swabbing and spraying in diphtheria. Resorcin cotton and resorcin gauze are used as dressings in surgery. There is also an ointment (10-per-cent.) much in use in diseases of the skin (eruption of scarlatina, of smallpox, etc.).

PYROGALLIC ACID AND OTHER TRIOXYBENZOLS.

The phenols of this group—pyrogallic acid, phlocoglycine, etc.—are still more active than the preceding; they are little used in medicine.

Pyrogallic acid is toxic by reason of its avidity for oxygen, which it takes from the blood, producing

accidents resembling those of poisoning by phosphorus. A solution (2-per-cent.) of pyrogallic acid prevents the development of micro-organisms. It has been employed externally with benefit, notably in lepra and other affections of the skin. It is a good disinfectant, but it stains the skin and blackens surgical instruments.

GUAIACOL AND OTHER DERIVATIVES OF DIOXYBENZOLS.

Guaiacol, or *methyl-catechol* ($C_7H_8O_2$), is, as we have said, one of the principal constituents of creasote. It is a colorless liquid, with odor resembling creasote, little soluble in water, very soluble in alcohol and the fixed oils.

Guaiacol is more antiseptic than cresylol, and it is probable that to it creasote owes its antiseptic action. It is given in the dose of five to ten milligrammes, in the place of creasote; its odor and taste are less disagreeable.

In tuberculosis it is administered in solution in alcohol and water, or in cod-liver oil (Sahli), in inhalations (Schuller), in pills (Horner), or in subcutaneous injections (Picot) with iodoform in solution in oil.

Benzosol, or *benzoated guaiacol*, is more antiseptic and less irritant than guaiacol, dissolving more slowly in the stomach. It is administered in wafers (five to ten grammes a day) in the same circumstances as guaiacol (Sahli).

Carboxylic guaiacol is but little used.

Guaiacol benzophenoid has been employed in ocular surgery; it is soluble in water, and does not stain the skin.

Styracol is solid, and may be employed in powder to dust wounds and ulcers. It is a good antiseptic.

Styrone, found in commerce crystallized or liquid, has a disagreeable odor, resembling hyacinth. It is little soluble in water, very soluble in alcohol. It is an energetic antiseptic, non-toxic, non-irritant, and has been employed in the treatment of otitis media.

SALOL AND GUAIACOLSALOL.

Salol ($C_{13}H_{10}O_3$) is an antiseptic more energetic than salicylic acid. It is the *salicylate of phenyl;* crystallizes in plates which melt at 42° C.; is insoluble in water, glycerin, and the heavy oils of petroleum; soluble in twenty-five times its weight of absolute alcohol, in ether, chloroform, benzene, turpentine, and the essential oils. Its flavor and its odor resemble those of essence of wintergreen.

In the organism, in presence of the pancreatic juice and alkaline liquids, it breaks up into phenic and salicylic acids, and acts by its two constituents. There are reports of poisoning following the lavish administration of salol, due to phenic acid set free in the stomach; such toxic accidents would not be likely to follow any ordinary dose.

Salol is employed internally in rheumatism; it

has antiseptic and analgesic properties. The following formula is a convenient one:

℞ Salol.......................... ʒ j–ij.
Mucilage...................... ℥ vj.

M. Sig.: A tablespoonful every two hours.

Externally, salol is employed in powder for the dressing of wounds. More active than boric acid, it is less so than iodoform.

Camphorated salol is a syrupy liquid which results from moderately heating together salol and camphor. It is employed in the same cases as camphorated phenol and camphorated naphthol; its antiseptic value gives it a rank between the two.

Guaiacolsalol ($C_{14}H_{12}O_4$) is an antiseptic superior to salol, as its chemical formula indicates, and might with advantage be introduced into the materia medica.

THYMOL.

Thymol ($C_{10}H_{14}O$), or *essence of thyme*, and *carvacrol* an isomer, are antiseptics superior to the cresols, and especially to the phenols. Thymol is obtained in large crystals, little soluble in water (1 to 1.50 per litre), soluble in alcohol and ether. It is much less toxic than phenic acid. Miquel classes it among the substances strongly antiseptic (equivalent, 2 grammes), between chloride of zinc and sulphate of nickel, but he considers it much less energetic than picric acid and very much less so than salicylic acid.

The figures given by Jalan de la Croix and those of Husmann place thymol before salicylic acid.

It must not be forgotten that if thymol ($C_{10}H_{14}O$) is more rich in hydrocarbons than salicylic acid ($C_7H_6O_3$), the latter is more rich in oxygen, and the researches of Rottenstein and Bourcart have taught us that the presence of a carboxyl group (COOH) much augments the antiseptic power of an oxybenzol or phenol. We believe then, till proof to the contrary is given, that Miquel is right, and that salicylic acid, salol, and guaiacolsalol are superior as antiseptics to thymol.

In practice, thymol presents certain disadvantages. It is quite irritant, very slowly soluble in water, and of high price.

It is chiefly in diarrhœa and dysentery that this medicament has been employed. In these affections the insolubility of the substance enables us to give it in large doses, and to obtain the disinfection of the intestine without fearing toxic effects due to absorption. It may be given in large doses—for instance, ten grains every two hours till sixty or ninety grains have been administered in the twenty-four hours.*

Thymol has been employed as a dentifrice, also

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*[Dr. F. P. Henry (*Therapeutic Gazette*, 1888, p. 683) advises to give this medicament in pill form, dose 2½ grains every six hours. He thinks that the same good effects are obtained from the small as from the large doses.—TRANSLATOR.]

in gargles, and in the form of ointments in affections of the skin and in burns.

ARISTOL.

Aristol, or *thymol biniodide*, or *biniodide* of *dithymol*, is an amorphous powder of a reddish-brown color, insoluble in water and glycerin, little soluble in alcohol, but very soluble in ether, the vegetable oils, and vaselin. It decomposes under solar light, and should be kept in black bottles. Although it contains 46 per cent. of iodine, it is not absorbed by open wounds.

As its very complicated composition indicates, it is a very powerful antiseptic, and may be used in the place of iodoform, being inodorous and less toxic than the latter. It has been employed in affections of the skin and as a dressing to wounds and ulcers.

CAMPHORS AND ESSENCES.

In the same category as thymol (essence of thyme) may be placed a great number of aromatic compounds, many of which are employed as antiseptics under the name of essences. The essences are hydrocarbons of the formula $C_{10}H_{16}$, which is that of the essence of turpentine, and of camphene the essence of camphor. The camphors differ by the presence of oxygen, which approximates them to the alcohols and phenols.

Ordinary *camphor* ($C_{10}H_6O$), Japan camphor, or Laurus camphora, has long been employed in medicine. Its incontestable antiseptic properties, and the

faculty it possesses of dissolving the phenols and naphthols, have for many years given it a high place.

Camphor is easily reduced to fine powder by adding a few drops of alcohol while it is in the mortar. It is very slightly soluble in water, but dissolves readily in alcohol, ether, the oils, and acetic acid.

Camphor is a feeble antiseptic, but it is chiefly employed as an excipient or dissolvant of the phenols and naphthols, giving us *camphorated phenol*, *camphorated salol*, *camphorated naphthol*. Camphor in powder, and these divers substances, blend readily at a temperature of 40° C. (104° F.), and form oily liquids very useful for dressing bad wounds, for painting diphtheritic sore-throat, etc., the feebly antiseptic action of the camphor being singularly reinforced by the energetic antiseptics associated with it.

Equal parts of camphor and chloral blend together into an oily liquid, which has both analgesic and antiseptic properties. Other substances, blend with camphor to effect a similar solution,* in the following proportions: Pyrogallic acid, twenty-five parts; thymol, five parts; salol, ten parts; phenol, equal parts; and naphthol β and salicylic acid, one-half of one part. All these camphor compounds are easily incorporated with vaselin and other fatty bodies. They are soluble in alcohol and ether, but not in water.

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* Desesquelle's table.

Borneol ($C_{10}H_{18}O$), or *Borneo camphor*, is, as indicated by its formula, a better antiseptic than ordinary camphor.

Essence of turpentine ($C_{10}H_{16}$) is, as its formula would suggest, a good antiseptic, useful in chronic diseases of the bronchi as an expectorant, and in advanced stages of typhoid fever (Geo. B. Wood). The dose in typhoid fever is 10 drops every two to four hours in syrup and mucilage. *Terpine* ($C_{10}H_{20}O_{2}$) is a derivative of turpentine.

Menthol, or *mint camphor*, is another good antiseptic of the same series. It is soluble in alcohol, ether, chloroform, etc. It has been chiefly employed as a topical agent, and in pulmonary catarrhs.

Oil of peppermint is a feeble antiseptic. It prevents the development of bacteria in solution of 1:50000, according to Koch.

Myrtol, or *essence of myrtle*, has been prescribed in chronic intestinal catarrhs (capsules, 2 to 3 grains).

Eucalyptol and *eugenol* are essences which are utilized as antiseptics in pulmonary and renal affections (in emulsion, in capsules, and in inhalations).

Eulyptol is a mixture of eucalyptol, salicylic acid, and phenol. It is a good antiseptic.

The essential oil of *cassia* (*Cassia fistula*) has been recently recommended as a good antiseptic (1:1000), in alcoholic solution or in emulsion in water.

RETINOL.

Retinol is the product of dry distillation of colo-

phene, which is itself the residue of the distillation of the turpentine of *Pinus pinaster*, having for formula $C_{44}H_{62}O_4$. Retinol is a liquid resembling olive oil and possessing a feeble pine odor.

It is an excellent antiseptic; is employed externally in its purity or as the excipient of a great number of medicaments. It dissolves salol (1:10), iodol (1:50), naphthol and aristol (1:50), camphor, cocaine, codeia, etc. When used as a solvent for resorcin, the latter must be first dissolved in glycerin. Retinol mixes with all the fatty bodies, sweet oil, vaselin, glycerin, etc.

It is not irritant, and does not change in the air.

Retinol has been employed pure in blennorrhagia, and more particularly in blennorrhagic vaginitis. For the latter purpose it is made to saturate a tampon, which is then introduced into the vagina and left there; it is not a painful application, and seems materially to abridge the duration of the disease.

In diseases of the skin, of the eyes, and of the ears, this body, which is easy to manage, may render important service both by its own action and as an excipient.

ANTISEPTIC MIXTURE OF SEVERAL ESSENCES.

Chamberland and Bouchard * have studied the antiseptic value of a certain number of vegetable es-

* Bouchard, "Therapeutique des Maladies Infectienses," p. 231.

sences. "There are some," says Bouchard, "which are as antiseptic as the mercurial salts. Six have no peer as antiseptics: these are the essences of origanum, China-canella, Ceylon-canella, angelica, vespetro, and Algiers geranium.

Bouchard has studied the antiseptic power of these essences, alone and combined, and finds the antiseptic equivalent high. It is well known that the ancient Egyptians employed various vegetable essences for embalming.

ACIDS OF THE AROMATIC SERIES.

These acids may be intercalated in the series of phenols which we have just been studying. They differ only by their acid function and the faculty of furnishing salts. They owe their properties to the carboxyl-group (COOH), which much augments, as we have said, the power of a component of this series. Most of them are powerful antiseptics; salicylic acid, for instance, is scarcely less so than salol, from which it differs by one CH_4 less.

We have already treated of tannic, thymic, and pyrogallic acids; we shall treat here of gallic, benzoic, salicylic, and oxynaphthoic acids.

GALLIC ACID AND GALLATES.

According to its formula, *gallic acid* is a more energetic microbicide than the trioxybenzols such as pyrogallic acid, from which it differs by the substitution of the group COOH for an equivalent of H. It

is crystalline, soluble in one hundred parts of cold water or three of boiling water, but is decomposed by exposure to the air, the solution becoming black. It is not much used.

Basic gallate of bismuth, or *dermatol*, is a saffron-yellow, inodorous powder which does not chauge in the air, is insoluble in water, alcohol, etc. It is neither irritant nor toxic. It is an excellent antiseptic, which may be substituted for iodoform in the dressing of wounds; it promotes cicatrization. It is given internally in the dose of 10 grains three times a day. It owes its properties in great part to its insolubility.

BENZOIC ACID AND THE BENZOATES.

Benzoic acid ($C_7H_6O_2$) is crystalline, little soluble in cold water, soluble in twelve parts of boiling water, and distills with the vapor of water. In the organism it is eliminated by the urine under the form of hippuric acid.

As an antiseptic it comes immediately after salicylic acid among the bodies strongly antiseptic (equivalent, 1.10 grammes, according to Miquel).

Several benzoates have been used as diuretics and antiseptics.

Benzoate of soda is soluble in water, and has been employed in the treatment of renal affections and in diphtheria. Its solubility makes it available for all cases where it is desired to administer benzoic acid internally.

Benzoate of bismuth is a white, insoluble powder which may be employed instead of iodoform. It has recently been proposed to substitute it for salicylate of bismuth for internal administration, especially when the kidney is diseased.

SALICYLIC ACID AND THE SALICYLATES.

Salicylic acid ($C_7H_6O_3$) is crystalline, little soluble in cold water (1:400), quite soluble in boiling water, very soluble in alcohol and ether. According to Miquel, it is of all the organic acids (with the exception of hydrocyanic acid) the most powerful antiseptic (equivalent, one gramme); and as it is feebly toxic (therapeutic equivalent, 40 centigrammes for one kilogramme, according to Bouchard), there is an indication for its employment whenever we wish to obtain an energetic antiseptic action without resorting to corrosive sublimate or the other inorganic compounds of the same nature. It is preferable to phenic acid, which has a disagreeable odor and a lower therapeutic equivalent (5 centigrammes).

Its action on the organism ought, at the same time, to be watched. It is eliminated very rapidly by the urine, and if the renal filter is altered (as in albuminuria) there may be toxic effects, even in the feeble dose of a gramme.

Under ordinary, normal circumstances, salicylic acid may be given in the dose of 4 to 6 grammes (ʒ j.–jss) a day in acute rheumatism. It is better

to administer it in the form of salicylate of soda or lithia. Externally, it is employed as a powder or in alcoholic solution (2 per cent.).

Salicylate of methyl, or *essence of wintergreen* (obtained from the *Gaultheria procumbens*), is a substance from which chemists first obtained salicylic acid. This essence, which is much used as a perfume, is a good antiseptic, superior even to salicylic acid, from which it differs by one CH_3 more.

Salicylate of phenyl is *salol*, which has been considered above.

Salicylate of soda is given in doses amounting to sixty or even ninety grains a day in acute rheumatism, gout, etc. The presence of the sodium much lowers the bactericidal power of the compound. According to Miquel, this salt is but moderately antiseptic (equivalent, 10 grammes, *i.e.*, ten times as much as the pure salicylic acid). Salicylate of soda is very soluble in water.

Salicylate of lithia is, in Vulpian's estimation, superior to salicylate of soda in acute rheumatism.

Salicylate of bismuth is insoluble in water. It is much employed instead of the nitrate in intestinal antisepsis. A dose of five grains may be given with safety every two hours. It is given in typhoid fever, in putrid dyspepsias, in intestinal affections, etc., where the indication is to disinfect the alimentary canal. It has been used externally in eczematous affections, and in the intertrigo of infants.

Salicylate of quinine will be considered along with the salts of quinine.

OXYNAPHTHOIC ACID.

This acid ($C_{10}H_8O_3$) is said to be more antiseptic than salicylic acid, but it is very irritant. The alkaline solutions of the *alpha* acid are alone used; they destroy the *staphylococcus pyogenes* in two or three hours. This acid is but little soluble in water, but quite soluble in alkalies and in alcohol.

AROMATIC COMPOUNDS CONTAINING CO—COUMARINE.

The compounds of this group, designated under the names of *ketones*, *quinones*, etc., are but little used in medicine.

Coumarine, obtained from the Tonka bean, is an odorous essential oil, resembling by its properties benzoic acid, and insoluble in water. It is much used to mask the odor of iodoform, but its high price limits its usefulness. It is a good antiseptic, and may be used where benzoic acid does good.

AROMATIC COMPOUNDS OF THE GROUP NAPHTYL, OR NAPHTHOLS.

As we have said above, the naphthols or phenols containing the group *naphtyl* ($C_{10}H_7$) are the best antiseptics of this series. They are about as energetic again as the phenols of the phenyl group (C_6H_5), and are generally preferred to the phenols in therapeutics.

NAPHTHALINE.

Naphthaline ($C_{10}H_8$), a hydrocarbon derivative from benzene, is, like it, one of the products of the distillation of coal-tar. When pure, it is in the form of brilliant plates, fusible at 79° C., subliming at a little higher temperature, and distilling with the vapor of boiling water; insoluble in water, quite soluble in alcohol, very soluble in ether. It burns with a sooty flame.

Naphthaline is a good antiseptic, and has the advantage of being but little toxic. It has been employed with success in intestinal antisepsis, but physicians prefer to-day naphthol and betol. Its properties explain the good effects obtained in whooping-cough by the empirical treatment which consists in taking children affected by this disease to the gas-houses where the atmosphere of the rooms is saturated with naphthaline, and making them stay there a number of hours. Garnier proposes to substitute for this troublesome method, inhalations made at the patient's home and in the sick-room by means of bougies containing naphthaline—to be burned on a platter. It may also be employed under the form of spray mingled with vapor of water, owing to its ready sublimation at the temperature of boiling water.

NAPHTHOLS.

There exist two isomeric derivatives of naphthaline, which, under the names of naphthol alpha and

naphthol beta, have both the formula $C_{10}H_8O$ and are the phenols of naphthaline.

Naphthol alpha is crystalline, fusible at 94° C., almost insoluble in water (1:5000), soluble in alcohol and ether, glycerin, benzene, the oils, and boric water. It is a good antiseptic, superior to its isomer although less toxic. The latter is, however, thus far, the more used in therapeutics.

Naphthol beta crystallizes in brilliant plates, sometimes of a rose tint, fusible at 112° C., presenting the same solubility as its isomer. It is a powerful antiseptic, preferable to naphthaline, because it is without odor and does not cause, like the latter, disagreeable odorous eructations; it is, besides, less toxic, as the following table indicates:

	Naphthol B.	Naphthaline.
Antiseptic equivalent..................	0.40	1.51
Toxic equivalent	3.80	3.40
Therapeutic equivalent................	1.10	1.00

Naphthol is given internally in capsules to protect the mouth and gullet from its irritant action; the dose, in typhoid fever, is 5 grains every four hours. Twice and three times this quantity may be given without toxic effects. A good way to obtain intestinal antisepsis is to combine 5 grains of naphthol with 5 of salicylate of bismuth, which will just fill a large-sized capsule; six of these may be given in the twenty-four hours.

The alcoholic solution of naphthol (3 to 5 per

cent.), the naphthol oil, and the naphthol ointment, are used externally.

Camphorated Naphthol and Sulphoricinated Naphthol.—The preparations designated under this name are simple mixtures which facilitate the employment of naphthol, and not definite compounds. They are employed in the dressing of wounds, and especially in the treatment of diphtheria.

The two naphthols easily blend with camphor, as we have said above, and at a temperature of about 100° F.

Camphorated naphthol is an oily or syrupy liquid, used to swab or paint the diseased parts. It gives excellent results in diphtheria, but its application is painful. It may be advisable in children to paint the throat previously with a 2-per-cent. solution of cocaine. The camphorated naphthol may be combined with cocaine. This topical application has given results still more marked in buccal tuberculosis, in coryza and furunculosis (Fernet).

Sulphoricinated naphthol has the advantage over camphorated naphthol of being, in its application, almost painless, because the presence of sulphoricinic acid or sulphoricinate of soda prevents the caustic action of the naphthol. The formula is ten parts of naphthol to ninety of sulphoricinate of soda. It is a very thick, syrupy, or oily liquid, with almost no odor, and with a taste a little like that of castor oil; is very adherent to the skin and mucous membranes. Like

camphorated naphthol, it is painted over the diphtheritic false membranes. (See further on: *Sulphoricinic acid.*)

Betol and Benzonaphthol.—Betol is a salicylate of naphthol beta, obtained by the direct action of the two compounds; it is crystalline, white, inodorous, tasteless; insoluble in water. As its composition indicates, its antiseptic power should be superior to that of naphthol; it is less irritant than naphthol, especially to the digestive tube, and is given in the same doses as the latter (7½ grains in capsules).

Benzonaphthol, or benzoate of naphthol, may be substituted for the above with the special indications for benzoic acid and the benzoates.

Hydronaphthol ($C_{10}H_9O_2$) is the result of the oxidation of naphthol beta, from which it differs by the incorporation by the group OH. It is less soluble than naphthol, and is administered in smaller doses. The dose for internal use is two to five grains. For external use, a solution of alcohol and glycerin (one part hydronaphthol, nine of alcohol, and ninety of glycerin) is diluted with three-quarters as much water, and has very energetic parasiticide effects in the treatment of parasitic affections of the skin.

AROMATIC COMPOUNDS WITH SULPHUR AND IODINE.

In these organic compounds, the action of sul-

phur and sometimes of iodine is added to that of the hydrocarbon (phenol) to augment the antiseptic energy. We may designate especially aseptol, sozoiodol, sulphobenzoate of soda, ichthyol, thioresorcin, sulphoricinic acid, essence of mustard, etc., compounds which are not all well defined, and whose therapeutic action has not thus far been sufficiently studied.

ASEPTOL.

Sulphurous orthophenylic acid, or sozolic acid ($C_6H_5O.SO_3H$), introduced into therapeutics under the name of aseptol by Serrant, is obtained by the slow action of sulphuric on phenic acid. It is crystalline, deliquescent, soluble in all proportions in water, alcohol, and glycerin. It is more acid and less caustic than phenic acid, forming with bases crystallizable salts.

It is an energetic antiseptic, less toxic than phenic and salicylic acids (Serrant and Annesseux). Its antiseptic power is due especially to its property of saturating the ammoniacal bases. It is little used.

SOZOIODOL.

Sozoiodol, a compound containing both sulphur and iodine, has the formula $C_6H_4SO_4I_2$. It is an acid (iodoparaphenylsulphuric acid), and combines with soda and potash to form salts. It is an energetic bactericide, which it has been proposed to substitute for iodoform, as being less toxic and having a less disagreeable odor.

Solutions are employed of the free acid or of the salts of sodium or aluminium (2 or 3 per cent.); the sozoiodol of zinc is also used in powder or solution in glycerin, and there is a sozoiodol gauze, a sozoiodol cotton, and a sozoiodol of mercury. These preparations are still little used.

SULPHORICINIC ACID.

This acid is employed chiefly as a solvent and excipient, under the names of *mercurial solvent*, *sulpholeine*, *sulpholeic acid*, etc. It is obtained by the action of sulphuric acid on castor oil.

But it is the *sulphoricinate of soda* which is employed. This is a thick, transparent, deep yellow, syrupy liquid, having an oily feel, and very adherent to the skin. Its odor is almost *nil;* its savor, which is but little marked, resembles that of castor oil, but does not leave on the tongue any disagreeable or acrid sensation. It forms with water very stable whitish emulsions. It has been chiefly employed to dissolve a great number of antiseptics which are but little soluble in water, such as phenic acid, creasote and the cresols, salol and naphthol. These solutions are made with the aid of heat. They become transparent after remaining a certain time, except the naphthol solution, which continues turbid.

There is a popular mixture consisting of four parts of phenol, one of naphthol, one of creasote or salol, with six to nine of the sulphoricinate of soda,

which forms an excellent topical application, and when cold presents the consistence of an ointment; it is much employed in the treatment of diphtheria. Grancher highly recommends for this disease a 30-per-cent. solution of phenic acid in sulphoricinate of soda.

ICHTHYOL.

We designate under this name a sort of mineral tar obtained by distilling certain fossil rocks (Schistes) of the Austrian Tyrol, which contain a great quantity of the remains of fossilized fishes, presenting still the relics of bituminous organic matters with considerable sulphur (15 per cent.). Ichthyol is, then, a badly defined product, of which it is difficult to appreciate the value as an antiseptic.

The ichthyol of commerce is a blackish-brown syrupy liquid, which mixes with water, and is soluble in alcohol and ether containing a little benzol.

Prescribed at first by Unna in the treatment of diseases of the skin, this medicament has been vaunted by Freund as of great value in gynæcology, especially in the treatment of chronic metritis and salpingitis. This author prescribes it to be used internally in pill form, and externally for painting the parts and saturating the tampons (being dissolved or diluted in glycerin).

[It is recommended by Robert Bell as a resolvent in chronic affections of the ovaries, tubes, cellular tissue of the pelvis, and even in hæmatocele. A gly-

cerole of ichthyol, mixed with boric acid (10 per 100), is employed. A tampon saturated with this mixture is placed in the vagina, and may be kept there for three days. Schadewitsch lauds ichthyol in erysipelas. At first using it in collodion, he subsequently employed it in ointment with an equal quantity of lard spread upon the diseased area and a little beyond. On the face no covering was used; on the body, paraffine paper. A good formnla is: Ichthyol and sulphuric ether, of each, one part; collodion, two parts.]

THIORESORCIN.

This sulphuretted product of resorcin is of a pale yellow color, almost insoluble in water, little soluble in alcohol, but its salts dissolve well in water. It is an antiseptic little employed.

AROMATIC COMPOUNDS CONTAINING NO_2.

These compounds are all antiseptic, but more feebly than those containing the groups OH or COOH. We have, in fact, seen that nitrogen much diminishes the bactericide power which the two O's would have given to the substance. Moreover, the antiseptic power is in relation to the number of NO_2 groups which the substance contains; thus nitrobenzin ($C_6H_5NO_2$) is less antiseptic than picric acid ($C_6H_3O.3NO_2$).

NITROBENZENE, OR ESSENCE OF MIRBANE.

This compound ($C_6H_5NO_2$) is a yellowish liquid, with a sweet taste and the agreeable odor of bitter almonds, and is employed in perfumery. Miquel classes it among the substances *strongly* antiseptic (equivalent, 2.60 grammes); but it must be remembered that it is toxic, and this forbids its employment internally.

ESSENCE OF BITTER ALMONDS.

Under this name is designated a combination of benzoic aldehyde and hydrocyanic acid, which is used in medicine (especially under the forms of *distilled water* and *essential oil* of bitter almonds) both internally and externally. Its antiseptic power is less than that of essence of mirbane (equivalent, 3 grammes). It is equally toxic, and the dose of one to five centigrammes should not be exceeded of the purified oil, or one to ten grammes of the distilled water.

PICRIC ACID.

This acid ($C_6H_3O3NO_2$), called also *trinitrophenol*, possesses an acid and bitter taste, is little soluble in cold water, soluble in alcohol and ether. It crystallizes in lemon-yellow needles, detonates under heat, and its salts (picrates) also detonate. As an antiseptic it is inferior to benzoic acid (its equivalent is 1.30 grammes, according to Miquel), and it is little used.

SULPHAMINOL.

This body is a yellow, inodorous, insoluble powder, which has been used instead of iodoform. It is a poor medicament, hardly deserving a place in the materia medica.

ESSENCE OF MUSTARD.

This essence is the *sulphocyanate of allyl* (C_3H_5-CSN). It has been prescribed by Koch as a powerful antiseptic, killing bacilli and their spores when it is in the state of vapor. If you put a drop of this essence into the bottom of a bell-jar which covers a culture of cholera bacilli, these will not develop, and will all be killed in the course of twenty-four hours (Babes). Its antiseptic power is inferior to that of benzoic acid (Jalan de la Croix).

ACETANILID; ASEPTIN; EXALGIN.

Acetanilid (C_8H_9NO), or antifebrin, and *exalgin*, or methylacetanilid, should also be regarded as antiseptics.

Aseptin, or monobromacetanilid, is an energetic bactericide.

Aseptinic acid is liquid, soluble in water, and, according to Linde, is a non-toxic antiseptic superior to iodoform. A 5-per-cent. solution is used for the dressing of wounds and for the preparation of an aseptic gauze.

§ 3.—ALKALOIDS.

We shall treat here of antipyrine and quinine, which interest us from the point of view of antisepsis. Remember that many of these compounds seem to be derived from a basic nucleus called pyridine (C_5H_5N).

ANTIPYRINE, OR ANALGESIN.

This body which is designated under the name dioxymethylquinizine ($C_{11}H_{12}N_2$) of the chemists, is chiefly employed in medicine as an analgesic and antipyretic. Its antiseptic properties are incontestable, and have recently been set forth by Visbecq as the result of experiments at the School of Lyons. Antipyrine presents the remarkable peculiarity of acting chiefly on the *toxines* secreted by the vegetal microbes. It has no action in malarial fevers. Vianna, prompted by laboratory experiments, has recently recommended it as an antiseptic to oppose the diphtheria bacillus. It is very soluble in water.

QUININE.

Quinine ($C_{20}H_{24}N_2O_2$) is the active principle of cinchona. Its salts are especially employed in medicine to combat malarial fevers, but are also of value in other affections of an intermittent nature.

We now know that malaria is caused by the presence in the blood of a micro-organism which is not a bacterium, but a protozoön of the class Sporozoa, and of the group Coccidia. Although the salts

of quinine are almost exclusively employed to combat this parasite, it is probable that many other antiseptics among those which we have previously studied would succeed equally well in the treatment of malarial fever. But decisive experiments to this effect are still lacking.

Per contra, we know with certainty that the preparations of quinine are also bactericides of a certain value. According to Miquel, the *hydrobromate* of quinine is to be classed among the substances *moderately* antiseptic (equivalent, 5.50 grammes). According to Marcus and Pinet, quinine chloride in the dose of seven or eight grains opposes the development of the bacteria of putrefaction, while in the dose of 4.50 grammes only it arrests their proliferation. Quinine probably has more action on the protozoa, but we have not yet any precise experiments to determine this, for the reason that the microorganism of malaria has not been cultivated.

According to what we now know of the antiseptic action of the various acids, the *salicylate* of quinine ought to be the most effective, by reason of the high equivalent of the salicylic acid. This salt is soluble in 900 parts of water. The basic salicylate contains 68 per cent. of quinine; the neutral salicylate 54 per cent.

Basic *bromhydrate* of quinine is soluble in sixty parts of water and contains 85 per cent. of quinine; the neutral salt is soluble in seven parts of water, and

contains 75 per cent. quinine. After the salicylate, this is probably the most active of the salts of quinine considered from an antiseptic point of view.

Basic *quinine chloride*, soluble in twenty-five parts of water, contains 83.6 per cent. of the alkaloid, and is, according to Dujardin-Beaumetz, more active than the sulphate.

Basic *sulphate* of quinine is but little soluble in water; it contains 74.3 per cent. of quinine.

The *neutral sulphate* is much more soluble, but contains only 59.12 per cent. of quinine. This is the salt in common use, and is easily obtained by acidifying, with a few drops of dilute sulphuric acid, watery emulsions containing the basic sulphate (the sulphate of commerce).

CINCHONINE, ANTISEPTOL.

The salts of cinchonine are succedanea of the salts of quinine, but have a more feeble action. I shall mention only *antiseptol*, or *iodosulphate of cinchonine*, which is an impalpable powder of a reddish-brown color, like kermes, inodorous, insoluble in water, soluble in chloroform and alcohol. It may be prepared extemporaneously by pouring a solution of ioduretted iodide of potassium into a solution of sulphate of cinchonine, washing, then drying the precipitate.

This antiseptic powder might replace iodoform, and would be quite as active; it contains 50 per cent. of iodine. There is need for a comparative study of antiseptol and the aristols.

RÉSUMÉ AND CONCLUSIONS—CRITICAL APPRECIATION OF THE RELATIVE VALUE OF THE ANTISEPTICS.

After having passed rapidly in review the numerous antiseptics which the therapeutic arsenal furnishes us, it is necessary to know how to make a proper choice among these medicaments. Each may present its advantages according to the indications of the disease and the particular properties of the antiseptic (solubility or insolubility, etc.).

For external antisepsis, the dressing of wounds and of natural cavities, corrosive sublimate and the other mercurial preparations occupy and will probably long keep the first rank. Near to corrosive sublimate we may place nitrate of silver, generally preferred for the treatment of diseases of the eyes. Phenic acid, after having long had a great popularity, is probably going more and more out of use. Next to the bichloride, iodoform is, of all antiseptics, the most used for the dressing of wounds and suppurating surfaces, and is an excellent medicament with hardly anything against it but its odor. Reserving iodoform for the gravest cases, the physician may in most cases substitute for it iodol, aristol, dermatol, antiseptol, and especially salol, which gives excellent results when we wish to obtain union by first intention. Creasote may, lastly, render service in the dressing of bad wounds.

For local antisepsis, notably of the mouth and throat, the bichloride should only be employed with the utmost caution. It is better to make use of bromol, of camphorated naphthol, or *sulphoricinated naphthol*, which seems to be really the most valuable medicine for the treatment of infectious and pseudo-membranous anginas.

The antisepsis of the intestinal canal in the dyspepsias, the enterites, and in typhoid fever, is sufficiently obtained by the aid of such antiseptics as are insoluble or little soluble, as naphthol, betol, and benzonaphthol, associated or not with salicylate of bismuth.

General or internal antisepsis is less advanced than local antisepsis. Salol, more powerful than salicylic acid, has been advantageously employed in rheumatism and analogous affections. Acetanilid acts in the same manner, but is a more feeble antiseptic. The salts of quinine (sulphate, bromhydrate, salicylate) are more suitable for malarial affections. Naphthol and betol have also a general action, beside their local action on tbe digestive tube, and present the advantage of being little toxic; thus 1000 grammes of living matter can support 13 centigrammes of naphthol alpha, which will sterilize 1084 grammes (Bouchard).

Hypodermatic or parenchymatous injections of antiseptic substances are still but little employed, although they are likely to have importance in the

future. At the same time, creasote in subcutaneous injections has given quite remarkable results in the treatment of tuberculosis. This medicament probably owes its curative effects to the property which it possesses of being eliminated, under a gaseous form, by the lungs, rather than to any really specific action on the bacillus of tuberculosis.

The essences, which are powerful antiseptics, have not yet in clinical practice proved to be as useful as we might have expected.

A word about the mixtures of several antiseptic substances, mixtures which, conformably to the law of Bouchard, *do not augment their toxic power, while increasing their antiseptic power.*—We have already seen the advantages which have been derived from sulphoricinated naphthol; it is by artifices of this kind that the employment of certain antiseptics will be rendered more and more practical.

To sum up: The simple antiseptics borrowed from mineral chemistry, or the mixed antiseptics such as iodoform, answer very well for external or local antisepsis. The complex antiseptics, borrowed from organic chemistry, are, on the contrary, much more suitable for internal antisepsis; we have seen that these compounds are but little toxic, and the more antiseptic (as a general rule) the more complex their molecule. It is to this very complication that they owe their property of being, like naphthol, "more deleterious to the vegetal parasite cell than to the

animal cell" (Bouchard). It is among these compounds of the aromatic series, and especially among the essences, that we must look for new antiseptics such as will enable us to realize general antisepsis without danger to the organism.

APPENDIX.

Note A.—Table of Jalan de la Croix, indicating the doses of antiseptics which neutralize the action of pathogenic bacteria.

[The figures represent the number of milligrammes employed to prevent the development of the bacteria, and to sterilize a litre of meat-juice serving as a culture-medium for the bacteria.]

PURE ANTISEPTICS.	DOSES		DOSES		DOSES	
	Which prevent.	Which do not prevent.	Which arrest.	Which do not arrest.	Which sterilize.	Which do not sterilize.
Corrosive sublimate......	40	20	170	154	80	66
Chlorine..................	33	24	44	33	2320	2170
Chloride of lime..........	90	76	268	224	5880	8875
Sulphurous acid.........	155	117	500	200	5265	3660
Sulphuric acid...........	170	120	500	300	8620	4900
Bromides	155	126	392	250	2975	1820
Iodides..................	200	150	646	500	2440	1916
Acetate of alumina......	235	184	2350	1200	15620	10870
Essence of mustard . ..	300	175	1690	1220	35700	25000
Benzoic acid............	350	250	2440	1960	8265	4760
Boro-salicylate of soda...	350	264	15890	9090	33300	20000
Boric acid...............	500	330	1000	700	6660	5000
Thymol..................	145	450	9175	4715	50000	27780
Salicylic acid...........	1000	893	18660	12820	....	28570
Permanganate of potash	1000	700	6660	5000	6600	5000
Phenic acid.............	1500	1000	45550	23810	376000	250000
Chloroform	11100	8930	8930	7460	... ...	1250000
Borax....................	15140	12990	20830	14500	....	83350
Alcohol	47620	28570	227300	166600	....	847000
Essence of eucalyptus...	71400	50000	8700	4800	....	171500

Note B.—Miquel's Table, indicating the smallest quantity of antiseptic substance necessary to prevent the putrefaction of a litre of beef bouillon neutralized, then exposed to the air.

In the substances eminently antiseptic are found the salts of mercury and silver; these constitute this group. It is understood that the figures which correspond to each one of these medicaments represent the minimum quantity capable of preventing the putrefaction of a litre of broth:

Biniodide of mercury	25	milligrammes.
Iodide of silver	30	"
Oxygenated water	50	"
Nitrate of silver	80	"
Bichloride of mercury	70	"

The second group comprises certain substances very powerfully antiseptic. They are as follows:

Osmic acid	15	centigrammes.
Chromic acid	20	"
Chlorine	25	"
Iodine	25	"
Chloride of gold	25	"
Bichloride of platinum	30	"
Hydrocyanic acid	40	"
Iodide of cadmium	50	"
Bromine	60	"
Iodoform	70	"
Chloride of copper	70	"
Chloroform	80	"
Cupric sulphate	90	"

Group 3: Substances powerfully antiseptic:

Salicylic acid	1.	gramme.
Benzoic acid	1.10	"
Cyanide of potassium	1.20	"
Bichromate ot potassium	1.20	"
Picric acid	1.30	"

Ammonia	1.40	grammes.
Zinc chloride	1.90	"
Essence of mirbane	2.60	"
Sulphuric acid, Nitric acid, Hydrochloric acid, Phosphoric acid,	2 to 3.	"
Essence of bitter almond	3.	"
Phenic acid	3.20	"
Permanganate of potash	3.50	"
Alum	4.50	"
Tannin	4.80	"
Oxalic acid, Tartaric acid, Citric acid,	3 to 5.	"
Sulphide of potassium	5.	"

Group 4: Substances moderately antiseptic:

Bromhydrate of quinine	3.50	grammes.
Arsenious acid	6.	"
Sulphate of strychnine	7.	"
Boric acid	7.50	"
Hydrate of chloral	9.30	"
Salicylate of sodium	10.00	"
Sulphate of protoxide of iron	11.00	"

In the fifth group (feebly antiseptic) we note:

Calcium chloride	40	grammes.
Sulphuric ether	22	"
Hydrochlorate of morphine	75	"
Ethyl alcohol	95	"
Borax	70	"

In the sixth and last group (very feebly antiseptic) we find:

Iodide of potassium	140	grammes.
Chloride of sodium	165	"
Glycerin	225	"
Bromide of potassium	240	"
Hyposulphite of sodium	275	"
Chloride of ammonium	115	"
Sulphite of ammonium	250	"

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